PROJECT: DESIGN AQUATIC CLIMBING WALL

CLIENT: PYRAMIDE USA INC.

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GKM Job # 91088

Dated: 11/30/09
Scope of Work:

AquaClimb climbing walls are to be installed permanently or semi permanently in various places throughout the country. In these locations the assembly may be subjected to a maximum of 100 mph wind load or a 250 lb climber located at the face of the wall. The purpose of this report is to analyze the AquaClimb assembly for these loads and design its components according to the AICS “Manual of Steel Construction”. Proper installation of the climbing wall assembly is the responsibility of others. Gary K. Munkelt & Associates shall take no responsibility of improper installation or use of this assembly. Design of existing pools or pool curbing to which this system may be connected is by others. Others are to ensure the material to which the AquaClimb assembly is anchored is constructed of competent material and provides enough ballast to resist maximum anchor loads.

References:


Material Specifications:

AquaClimb will be constructed of A304 stainless steel with yield strength of no less than 38 ksi & according to the AquaClimb aquatic climbing wall specification by Pyramide.

Conclusions:

When installed according to manufacturer’s instructions the assembly can withstand 100 mph wind loads or a 250 lb climber. As such it will also be in compliance with structural requirements of ASTM F2461-09.
**Analysis & Design Method:**

Geometry of the system has been optimized by the manufacturer based on the use of the wall. The component materials of assembly have been provided by the manufacturer and are set forth in the Aquatic Climbing Wall Specifications. Two loads cases for the design of the AquaClimb assembly will be considered. The first will be a maximum 250 lb climber located at the face of the wall. The second will be the pressure placed on an upright assembly from a 100 mph wind load as determined from the American Society of Civil Engineer publication ASCE&-05 “Minimum design Loads for Buildings and Other Structures”.

A model of the assembly will be built & analysis will then be performed using the structural design software MultiFrame 11.03 by Daystar Software, Inc. Kansa City, MO. This software has an integral design check module that will assess each section of the assembly for compliance with the American Institute of Steel Construction “Manual of Steel Construction” ASD method. The output for each of the members will constitute the bulk of this report. For ease of understanding the output sketched of the frame joint & member numbers have been included.

**Wind Loads:**

Per ASCE 7 with low hazard to human life in the event of failure

\[ Q_z = 0.00256 \, K_z \, K_{zt} \, K_d \, V^2 \, I \]

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**V. Wind Loads - Other Structures:**

<table>
<thead>
<tr>
<th>Importance Factor</th>
<th>0.87</th>
</tr>
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<tbody>
<tr>
<td>Gust Effect Factor (G)</td>
<td>0.85</td>
</tr>
<tr>
<td>Wind Speed</td>
<td>100 mph</td>
</tr>
<tr>
<td>Kzt</td>
<td>1.00</td>
</tr>
<tr>
<td>Exposure</td>
<td>B</td>
</tr>
</tbody>
</table>

**A. Solid Freestanding Walls & Solid Signs (& open signs with less than 30% open)**

<table>
<thead>
<tr>
<th>Dist to sign top (h)</th>
<th>12.7 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/s =</td>
<td>0.24</td>
</tr>
<tr>
<td>C' =</td>
<td>1.64</td>
</tr>
<tr>
<td>Height (s)</td>
<td>12.7 ft</td>
</tr>
<tr>
<td>Lr/s =</td>
<td>0.00</td>
</tr>
<tr>
<td>F = qz \cdot G \cdot C_f \cdot A_s =</td>
<td><strong>15.1</strong> As</td>
</tr>
<tr>
<td>Width (B)</td>
<td>3.0 ft</td>
</tr>
<tr>
<td>Kz =</td>
<td>0.575</td>
</tr>
<tr>
<td>As =</td>
<td>10.0 sf</td>
</tr>
<tr>
<td>Wall Return (Lr)</td>
<td>0.0 ft</td>
</tr>
<tr>
<td>qz =</td>
<td>10.9 psf</td>
</tr>
<tr>
<td>F =</td>
<td>151 lbs</td>
</tr>
<tr>
<td>Directionality (Kd)</td>
<td>0.85</td>
</tr>
</tbody>
</table>

ASCE W+D load combination governs design
Checking C:\Users\Frank Conklin\Desktop\aqua\11-30\aquaclimb.mfd to ASD code
Monday, November 30, 2009 7:30 PM

Checking design member 1 (Column)

Members: 1
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]
- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 51.42/0.586, 1.0 \times 51.42/0.586) = 87.747 \]

\[ F_a = (1 - (K_l/r)^2/(2 \times C_c^2)) \times F_y / FS = (1 - 87.747^2/(2 \times 119.63^2)) \times 40.0 / 1.892 = 15.451 \text{ ksi} \]

**Major Axis:**
- \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

**Minor Axis:**
- \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

**Design Member 1, wind on front, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 10.751 \leq 26.4 \text{ OK 59\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 10.751 \leq 26.4 \text{ OK 59\% under} \]

**Design Member 1, wind on front, Major Shear**
- \( f_s \leq F_v, \ 0.342 \leq 16.0 \text{ OK 98\% under} \)

**Design Member 1, wind on front, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 4.108 \leq 26.4 \text{ OK 84\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 4.108 \leq 26.4 \text{ OK 84\% under} \]

**Design Member 1, wind on front, Minor Shear**
- \( f_s \leq F_v, \ 0.093 \leq 16.0 \text{ OK 99\% under} \)

**Design Member 1, wind on front, Tension**
- On gross area \( f_t \leq F_t, \ 2.344 \leq 24.0 \text{ OK 90\% under} \)
- On net area \( f_t \leq F_u, \ 2.344 \leq 44.0 \text{ OK 95\% under} \)

**Design Member 1, wind on front, Compression**
- \( f_a \leq F_a, \ 0.0 \leq 15.451 \text{ OK 100\% under} \)

**Design Member 1, wind on front, Bending + Tension**
- \( f_y/F_t + f_bx/F_bx + f_by/F_by = 2.344 + 24.0 + 10.751/26.4 + 4.108/26.4 = 0.66 \leq 1 \text{ OK 34\% under} \)

**Design Member 1, wind on front, Bending + Compression**
- \( f_y/F_a = 0.0/15.451 = 0.0 \leq 0.15 \quad \therefore \phi \)

**Load Case: climber**
- \( F_y = 40.0 \text{ ksi} \)
- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area $F_t = 0.5\times F_u = 0.5\times 88.0 = 44.0$ ksi

$F_y = 0.4\times F_y = 0.4\times 40.0 = 16.0$ ksi

$K_l/r = \max(K_x + l/r, K_y + l/r) = \max(1.0 + 51.42/0.586, 1.0 + 51.42/0.586) = 87.747$

$F_a = (1 - (K_l/r)^2(2+Cc^2)) + F_y/F_S = (1 - 87.747^2(2+119.63^2)) + 40.0/1.892 = 15.451$ ksi

**Major Axis:**
$F_a = 0.66\times F_y = 0.66\times 40.0 = 26.4$ ksi

**Minor Axis:**
$F_a = 0.66\times F_y = 0.66\times 40.0 = 26.4$ ksi

**Design Member 1, climber, Major Bending**

Tensile Bending Stress:
$f_b \leq F_b$, $2.451 \leq 26.4$ OK 91% under

Compressive Bending Stress:
$f_b \leq F_b$, $2.451 \leq 26.4$ OK 91% under

**Design Member 1, climber, Major Shear**

$f_v \leq F_v$, $0.042 \leq 16.0$ OK 100% under

**Design Member 1, climber, Minor Bending**

Tensile Bending Stress:
$f_b \leq F_b$, $1.256 \leq 26.4$ OK 95% under

Compressive Bending Stress:
$f_b \leq F_b$, $1.256 \leq 26.4$ OK 95% under

**Design Member 1, climber, Minor Shear**

$f_v \leq F_v$, $0.03 \leq 16.0$ OK 100% under

**Design Member 1, climber, Tension**

On gross area $f_t \leq F_t$, $0.0 \leq 24.0$ OK 100% under

On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 1, climber, Compression**
$f_a \leq F_a$, $0.671 \leq 15.451$ OK 96% under

**Design Member 1, climber, Bending + Tension**

$f_a/F_t + f_b/F_b + f_y/F_y = 0.043 \leq 0.15 \rightarrow \phi_0 = 0.0$.

**Load Case: wind on back**

$F_y = 40.0$ ksi

On gross area $F_t = 0.6\times F_y = 0.6\times 40.0 = 24.0$ ksi

On net area $F_t = 0.5\times F_u = 0.5\times 88.0 = 44.0$ ksi

$F_y = 0.4\times F_y = 0.4\times 40.0 = 16.0$ ksi

$K_l/r = \max(K_x + l/r, K_y + l/r) = \max(1.0 + 51.42/0.586, 1.0 + 51.42/0.586) = 87.747$

$F_a = (1 - (K_l/r)^2(2+Cc^2)) + F_y/F_S = (1 - 87.747^2(2+119.63^2)) + 40.0/1.892 = 15.451$ ksi

**Major Axis:**
$F_a = 0.66\times F_y = 0.66\times 40.0 = 26.4$ ksi

**Minor Axis:**
$F_a = 0.66\times F_y = 0.66\times 40.0 = 26.4$ ksi

**Design Member 1, wind on back, Major Bending**

Tensile Bending Stress:
$f_b \leq F_b$, $10.751 \leq 26.4$ OK 59% under

Compressive Bending Stress:
$f_b \leq F_b$, $10.751 \leq 26.4$ OK 59% under

**Design Member 1, wind on back, Major Shear**

$f_v \leq F_v$, $0.342 \leq 16.0$ OK 98% under

**Design Member 1, wind on back, Minor Bending**

Tensile Bending Stress:
$f_b \leq F_b$, $4.108 \leq 26.4$ OK 84% under

Compressive Bending Stress:
$f_b \leq F_b$, $4.108 \leq 26.4$ OK 84% under
Design Member 1, wind on back, Minor Shear
\[ f_v \leq F_v, \; 0.093 \leq 16.0 \text{ OK 99\% under} \]

Design Member 1, wind on back, Tension
- On gross area \( f_t \leq F_t, \; 0.0 \leq 24.0 \text{ OK 100\% under} \)
- On net area \( f_t \leq F_t, \; 0.0 \leq 44.0 \text{ OK 100\% under} \)

Design Member 1, wind on back, Compression
\[ f_a \leq F_a, \; 2.344 \leq 15.451 \text{ OK 85\% under} \]

Design Member 1, wind on back, Bending + Tension
\[ f_a/F_a+f_{bx}/F_{bx}+f_{by}/F_{by}=0.0/44.0+10.751/26.4+4.108/26.4=0.563 \leq 1 \text{ OK 44\% under} \]

Design Member 1, wind on back, Bending + Compression
Axial Ratio=\( f_a/F_a=2.344/15.451=0.152 \)
Major Ratio=\( C_{mx} f_{bx}/((1-f_a/F'_{ex})+F_{bx})=1.0*10.751/((1-2.344/19.395)*26.4)=0.463 \)
Minor Ratio=\( C_{my} f_{by}/((1-f_a/F'_{ey})+F_{by})=1.0*4.108/((1-2.344/19.395)*26.4)=0.177 \)
Axial Ratio+Major Ratio+Minor Ratio=0.152+0.463+0.177=0.792 \leq 1 \text{ OK 21\% under} \)
\[ f_a/(0.6\times F_y)+f_{bx}/F_{bx}+f_{by}/F_{by}=2.344/(0.6\times 40.0)+10.751/26.4+4.108/26.4=0.66 \geq 1 \text{ OK 34\% under} \]
Checking design member 2 (Column)

Members: 2
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

Load Case: climber

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GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS
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Calc by: FJC  
AquaClimb  
11/24/2009

\[ F_a = (1 - \frac{(KL/r)^2}{2(2+Cc^2)}) + \frac{F_y}{FS} = (1 - 67.19^2/(2+119.63^2)) + 40.0/1.855 = 18.161 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 + \frac{F_y}{FS} = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 + \frac{F_y}{FS} = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Design Member 2, climber, Major Bending**
Tensile Bending Stress:
\[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK } 100\% \text{ under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK } 100\% \text{ under} \]

**Design Member 2, climber, Major Shear**
\[ f_s \leq F_s, \ 0.011 \leq 16.0 \text{ OK } 100\% \text{ under} \]

**Design Member 2, climber, Minor Bending**
Tensile Bending Stress:
\[ f_b \leq F_b, \ 0.338 \leq 26.4 \text{ OK } 99\% \text{ under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \ 0.338 \leq 26.4 \text{ OK } 99\% \text{ under} \]

**Design Member 2, climber, Minor Shear**
\[ f_s \leq F_s, \ 0.011 \leq 16.0 \text{ OK } 100\% \text{ under} \]

**Design Member 2, climber, Tension**
On gross area
\[ f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK } 100\% \text{ under} \]
On net area
\[ f_t \leq F_t, \ 0.0 \leq 44.0 \text{ OK } 100\% \text{ under} \]

**Design Member 2, climber, Compression**
\[ f_a \leq F_a, \ 0.68 \leq 18.161 \text{ OK } 96\% \text{ under} \]

**Design Member 2, climber, Bending + Tension**
\[ \phi_{\alpha} + \phi_{\beta} + \phi_{\gamma} + \phi_{\psi} = 0.68/18.161 + 0.0/44.0 + 0.338/26.4 = 0.013 \leq 1 \text{ OK } 99\% \text{ under} \]

**Load Case: wind on back**
\[ F_y = 40.0 \text{ ksi} \]

On gross area
\[ F_t = 0.6 + \frac{F_y}{FS} = 0.6 + 40.0 = 24.0 \text{ ksi} \]
On net area
\[ F_t = 0.5 + \frac{F_y}{FS} = 0.5 + 88.0 = 44.0 \text{ ksi} \]
\[ K_l/r = \max(K_{x} l/r_{x}, K_{y} l/r_{y}) = \max(1.0 \times 39.373/0.586, 1.0 \times 39.373/0.586) = 67.19 \]
\[ F_a = (1 - \frac{(KL/r)^2}{2(2+Cc^2)}) + \frac{F_y}{FS} = (1 - 67.19^2/(2+119.63^2)) + 40.0/1.855 = 18.161 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 + \frac{F_y}{FS} = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 + \frac{F_y}{FS} = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Design Member 2, wind on back, Major Bending**
Tensile Bending Stress:
\[ f_b \leq F_b, \ 1.399 \leq 26.4 \text{ OK } 95\% \text{ under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \ 1.399 \leq 26.4 \text{ OK } 95\% \text{ under} \]

**Design Member 2, wind on back, Major Shear**
\[ f_s \leq F_s, \ 0.095 \leq 16.0 \text{ OK } 99\% \text{ under} \]

**Design Member 2, wind on back, Minor Bending**
Tensile Bending Stress:
\[ f_b \leq F_b, \ 1.406 \leq 26.4 \text{ OK } 95\% \text{ under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \ 1.406 \leq 26.4 \text{ OK } 95\% \text{ under} \]

**Design Member 2, wind on back, Minor Shear**
\[ f_s \leq F_s, \ 0.043 \leq 16.0 \text{ OK } 99\% \text{ under} \]

**Design Member 2, wind on back, Tension**
On gross area
\[ f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK } 100\% \text{ under} \]
On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 2, wind on back, Compression**

$f_a \leq F_a$, $2.365 \leq 18.161$ OK 87% under

**Design Member 2, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 1.399/26.4 + 1.406/26.4 = 0.106 \leq 1$ OK 89% under

**Design Member 2, wind on back, Bending + Compression**

$f_a/F_a = 2.365/18.161 = 0.13 \leq 0.15 \therefore \phi$

$\phi_a/\Phi_a + \phi_{bz}/\Phi_{bz} + \phi_{by}/\Phi_{by} = 2.365/18.161 + 1.399/26.4 + 1.406/26.4 = 0.237 \leq 1$ OK 76% under
Checking design member 3

Members: 3
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 41.367/0.586, 1.0 \times 41.367/0.586) = 70.593 \]

- Major Axis:
  \[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

- Minor Axis:
  \[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Design Member 3, wind on front, Major Bending

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 13.653 \leq 26.4 \text{ OK 48% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 13.653 \leq 26.4 \text{ OK 48% under} \]

Design Member 3, wind on front, Major Shear

\[ f_v \leq F_v, \ 0.087 \leq 16.0 \text{ OK 99% under} \]

Design Member 3, wind on front, Minor Bending

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 4.055 \leq 26.4 \text{ OK 85% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 4.055 \leq 26.4 \text{ OK 85% under} \]

Design Member 3, wind on front, Minor Shear

\[ f_v \leq F_v, \ 0.0 \leq 44.0 \text{ OK 100% under} \]

Design Member 3, wind on front, Tension

- On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100% under} \)

- On net area \( f_t \leq F_t, \ 0.0 \leq 44.0 \text{ OK 100% under} \)

Design Member 3, wind on front, Compression

\[ f_a \leq F_a, \ 2.52 \leq 17.74 \text{ OK 86% under} \]

Design Member 3, wind on front, Bending + Tension

\[ f_v/(F_t + F_b x + F_b y)/F_{by} = 0.0/44.0 + 13.653/26.4 + 4.055/26.4 = 0.671 \leq 1 \text{ OK 33% under} \]

Design Member 3, wind on front, Bending + Compression

\[ f_v/F_a = 2.52/17.74 = 0.142 \leq 0.15 : \phi \]

\[ \psi_\alpha/\Phi_\alpha = \hat{\psi}_\alpha/\Phi_\alpha = \hat{\psi}_\alpha/\Phi_\alpha = 2.52/17.74 + 13.653/26.4 + 4.055/26.4 = 0.813 \leq 1 \text{ OK 19% under} \]

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]

- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 41.367/0.586, 1.0 \times 41.367/0.586) = 70.593 \]
\[ F_a = (1 - (KL/r)^2)/(2 + Cc^2)) \times F_y/FS = (1 - 70.593^2/(2 + 119.63^2)) + 40.0/1.862 = 17.74 \text{ ksi} \]

**Major Axis:** 
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:** 
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 3, climber, Major Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, \quad 2.728 \leq 26.4 \text{ OK 90\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, \quad 2.728 \leq 26.4 \text{ OK 90\% under} \]

**Design Member 3, climber, Major Shear**

\[ f_s \leq F_s, \quad 0.115 \leq 16.0 \text{ OK 99\% under} \]

**Design Member 3, climber, Major Bending**

**Load Case: wind on back**

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ K/l = \max(K_\alpha/l_\alpha, K_\beta/l_\beta) = \max(1.0 + 41.367/0.586, 1.0 + 41.367/0.586) = 70.593 \]

\[ F_a = (1 - (KL/r)^2)/(2 + Cc^2)) \times F_y/FS = (1 - 70.593^2/(2 + 119.63^2)) + 40.0/1.862 = 17.74 \text{ ksi} \]

**Major Axis:** 
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:** 
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 3, wind on back, Major Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, \quad 13.653 \leq 26.4 \text{ OK 48\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, \quad 13.653 \leq 26.4 \text{ OK 48\% under} \]

**Design Member 3, wind on back, Major Shear**

\[ f_s \leq F_s, \quad 0.215 \leq 16.0 \text{ OK 99\% under} \]

**Design Member 3, wind on back, Tension**

On gross area \( f_t \leq F_t, \quad 2.52 \leq 24.0 \text{ OK 89\% under} \)
On net area $f_t \leq F_t$, $2.52 \leq 44.0$ OK $94\%$ under

**Design Member 3, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 17.74$ OK $100\%$ under

**Design Member 3, wind on back, Bending + Tension**

\[
\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} = 2.52/24.0 + 13.653/26.4 + 4.055/26.4 = 0.776 \leq 1 \text{ OK } 22\% \text{ under}
\]

**Design Member 3, wind on back, Bending + Compression**

\[
\frac{f_a}{F_a} = 0.0/17.74 = 0.0 \leq 0.15 \therefore \phi_0
\]

\[
\phi_a/\Phi_a + \phi_{bx}/\Phi_{bx} + \phi_{by}/\Phi_{by} = 0.0/17.74 + 13.653/26.4 + 4.055/26.4 = 0.671 \leq 1 \text{ OK } 33\% \text{ under}
\]
Checking design member 4 (Column)

Members: 4
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

- On gross area: \[ F_t = 0.6 \times F_y = 24.0 \text{ ksi} \]
- On net area: \[ F_t = 0.5 \times F_y = 22.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 16.0 \text{ ksi} \]

\[ K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 39.85/0.586, 1.0 \times 39.85/0.586) = 68.003 \]

**Major Axis:**

\[ F_b = 0.66 \times F_y = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 \times F_y = 26.4 \text{ ksi} \]

**Design Member 4, wind on front, Major Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 3.509 \leq 26.4 \text{ OK 87% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 3.509 \leq 26.4 \text{ OK 87% under} \]

**Design Member 4, wind on front, Major Shear**

\[ f_v \leq F_v, \quad 0.176 \leq 16.0 \text{ OK 99% under} \]

**Design Member 4, wind on front, Minor Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 0.47 \leq 26.4 \text{ OK 98% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 0.47 \leq 26.4 \text{ OK 98% under} \]

**Design Member 4, wind on front, Minor Shear**

\[ f_v \leq F_v, \quad 0.021 \leq 16.0 \text{ OK 100% under} \]

**Design Member 4, wind on front, Tension**

- On gross area: \[ f_t \leq F_t, \quad 2.375 \leq 24.0 \text{ OK 90% under} \]
- On net area: \[ f_t \leq F_t, \quad 2.375 \leq 44.0 \text{ OK 95% under} \]

**Design Member 4, wind on front, Compression**

\[ f_a \leq F_a, \quad 0.0 \leq 18.061 \text{ OK 100% under} \]

**Design Member 4, wind on front, Bending + Tension**

\[ f_y/F_t + f_b/F_b + f_v/F_v = 2.375/24.0 + 3.509/26.4 + 0.47/26.4 = 0.25 \leq 1 \text{ OK 75% under} \]

**Design Member 4, wind on front, Bending + Compression**

\[ f_y/F_a = 0.0/18.061 = 0.0 \leq 0.15 \cdot \phi_0 \]

\[ \phi_0 = \frac{f_y}{F_a} \cdot \phi_x + \phi_y = \frac{f_y}{F_a} = 0.0/18.061 + 3.509/26.4 + 0.47/26.4 = 0.151 \leq 1 \text{ OK 85% under} \]

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]

- On gross area: \[ F_t = 0.6 \times F_y = 24.0 \text{ ksi} \]
- On net area: \[ F_t = 0.5 \times F_y = 22.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 16.0 \text{ ksi} \]

\[ K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 39.85/0.586, 1.0 \times 39.85/0.586) = 68.003 \]
\[
F_a = (1-(KL/r)^2/(2+Cc^2)) \cdot F_y / FS = (1-68.003^2/(2+119.63^2)) \cdot 40.0 / 1.857 = 18.061 \text{ ksi}
\]

**Major Axis:**
\[
F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**
\[
F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi}
\]

### Design Member 4, Climber, Major Bending
- **Tensile Bending Stress:**
  \[f_{b} \leq F_{b}, \quad 0.525 \leq 26.4 \text{ OK 98% under} \]
- **Compressive Bending Stress:**
  \[f_{b} \leq F_{b}, \quad 0.525 \leq 26.4 \text{ OK 98% under} \]

### Design Member 4, Climber, Major Shear
\[f_{v} \leq F_{v}, \quad 0.012 \leq 16.0 \text{ OK 100% under} \]

### Design Member 4, Climber, Minor Bending
- **Tensile Bending Stress:**
  \[f_{b} \leq F_{b}, \quad 0.131 \leq 26.4 \text{ OK 100% under} \]
- **Compressive Bending Stress:**
  \[f_{b} \leq F_{b}, \quad 0.131 \leq 26.4 \text{ OK 100% under} \]

### Design Member 4, Climber, Minor Shear
\[f_{v} \leq F_{v}, \quad 0.004 \leq 16.0 \text{ OK 100% under} \]

### Design Member 4, Climber, Tension
- **On gross area**
  \[f_{t} \leq F_{t}, \quad 0.0 \leq 24.0 \text{ OK 100% under} \]
- **On net area**
  \[f_{t} \leq F_{t}, \quad 0.0 \leq 44.0 \text{ OK 100% under} \]

### Design Member 4, Climber, Compression
\[f_{a} \leq F_{a}, \quad 0.325 \leq 18.061 \text{ OK 98% under} \]

### Design Member 4, Climber, Bending + Tension
\[
f_{a} / F_{t} + f_{b} / F_{b} + f_{v} / F_{v} / F_{a} = 0.0 / 44.0 + 0.525 / 26.4 + 0.131 / 26.4 = 0.025 \leq 1 \text{ OK 98% under} \]

### Design Member 4, Climber, Bending + Compression
\[
\phi_{F_a} / \phi_{F_b} + \phi_{F_v} / \phi_{F_v} = 0.325 / 18.061 + 0.525 / 26.4 + 0.131 / 26.4 = 0.043 \leq 1 \text{ OK 96% under} \]

### Load Case: Wind on Back
\[F_{y} = 40.0 \text{ ksi} \]
- **On gross area**
  \[f_{t} \leq F_{t}, \quad 0.6 \cdot F_{y} = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \]
- **On net area**
  \[f_{t} \leq F_{t}, \quad 0.5 \cdot F_{u} = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \]
\[F_{v} = 0.4 \cdot F_{y} = 0.4 \cdot 40.0 = 16.0 \text{ ksi} \]
\[KL/r = \max(K_{x} \cdot l/r_{x}, K_{y} \cdot l/r_{y}) = \max(1.0 \cdot 39.85 / 0.586, 1.0 \cdot 39.85 / 0.586) = 68.003 \]
\[F_{a} = (1-(KL/r)^2/(2+Cc^2)) \cdot F_{y} / FS = (1-68.003^2/(2+119.63^2)) \cdot 40.0 / 1.857 = 18.061 \text{ ksi} \]
- **Major Axis:**
  \[F_{b} = 0.66 \cdot F_{y} = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]
- **Minor Axis:**
  \[F_{b} = 0.66 \cdot F_{y} = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

### Design Member 4, Wind on Back, Major Bending
- **Tensile Bending Stress:**
  \[f_{b} \leq F_{b}, \quad 3.509 \leq 26.4 \text{ OK 87% under} \]
- **Compressive Bending Stress:**
  \[f_{b} \leq F_{b}, \quad 3.509 \leq 26.4 \text{ OK 87% under} \]

### Design Member 4, Wind on Back, Major Shear
\[f_{v} \leq F_{v}, \quad 0.176 \leq 16.0 \text{ OK 99% under} \]

### Design Member 4, Wind on Back, Minor Bending
- **Tensile Bending Stress:**
  \[f_{b} \leq F_{b}, \quad 0.47 \leq 26.4 \text{ OK 98% under} \]
- **Compressive Bending Stress:**
  \[f_{b} \leq F_{b}, \quad 0.47 \leq 26.4 \text{ OK 98% under} \]

### Design Member 4, Wind on Back, Minor Shear
\[f_{v} \leq F_{v}, \quad 0.021 \leq 16.0 \text{ OK 100% under} \]

### Design Member 4, Wind on Back, Tension
- **On gross area**
  \[f_{t} \leq F_{t}, \quad 0.0 \leq 24.0 \text{ OK 100% under} \]
Design Member 4, wind on back, Compression
\[ f_a \leq F_a, \quad 2.375 \leq 18.061 \text{ OK 87\% under} \]

Design Member 4, wind on back, Bending + Tension
\[ f_a / F_a + f_b / F_b + f_c / F_c = 0.0 / 44.0 + 3.509 / 26.4 + 0.47 / 26.4 = 0.151 \leq 1 \text{ OK 85\% under} \]

Design Member 4, wind on back, Bending + Compression
\[ f_a / F_a = 2.375 / 18.061 = 0.132 \leq 0.15 : \phi_0 \]
\[ \phi_{\alpha} / \Phi_{\alpha} + \phi_{\beta} / \Phi_{\beta} + \phi_{\gamma} / \Phi_{\gamma} = 2.375 / 18.061 + 3.509 / 26.4 + 0.47 / 26.4 = 0.282 \leq 1 \text{ OK 72\% under} \]
Checking design member 5

Members: 5
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area
\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area
\[ F_t = 0.5 \times F_y = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 41.425/0.586, 1.0 \times 41.425/0.586) = 70.69 \]

\[ F_a = (1 - (K_l/r)^2/(2 \times C_c^2)) \times F_y / FS = (1 - 70.69^2/(2 \times 119.63^2)) \times 40.0 / 1.862 = 17.727 \text{ ksi} \]

Major Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Minor Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Design Member 5, wind on front, Major Bending

Tensile Bending Stress:
\[ f_b \leq F_b, \quad 3.645 \leq 26.4 \text{ OK 86\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, \quad 3.645 \leq 26.4 \text{ OK 86\% under} \]

Design Member 5, wind on front, Major Shear

\[ f_v \leq F_v, \quad 0.072 \leq 16.0 \text{ OK 100\% under} \]

Design Member 5, wind on front, Minor Bending

Tensile Bending Stress:
\[ f_b \leq F_b, \quad 0.159 \leq 26.4 \text{ OK 99\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, \quad 0.159 \leq 26.4 \text{ OK 99\% under} \]

Design Member 5, wind on front, Minor Shear

\[ f_v \leq F_v, \quad 0.0 \leq 16.0 \text{ OK 100\% under} \]

Design Member 5, wind on front, Tension

On gross area
\[ f_t \leq F_t, \quad 0.0 \leq 24.0 \text{ OK 100\% under} \]

On net area
\[ f_t \leq F_t, \quad 0.0 \leq 44.0 \text{ OK 100\% under} \]

Design Member 5, wind on front, Compression

\[ f_a \leq F_a, \quad 2.456 \leq 17.727 \text{ OK 86\% under} \]

Design Member 5, wind on front, Bending + Tension

\[ f_y/F_t + f_x/F_{tx} + f_y/F_{ty} = 0.0/44.0 + 3.645/26.4 + 0.159/26.4 = 0.144 \leq 1 \text{ OK 86\% under} \]

Design Member 5, wind on front, Bending + Compression

\[ f_y/F_a = 2.456/17.727 = 0.139 \leq 0.15 \quad \phi = 0 \]

\[ \phi_a + \phi_{tx} + \phi_{ty} + \phi_{tv} = 2.456/17.727 + 3.645/26.4 + 0.159/26.4 = 0.283 \leq 1 \text{ OK 72\% under} \]

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]

On gross area
\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area
\[ F_t = 0.5 \times F_y = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 41.425/0.586, 1.0 \times 41.425/0.586) = 70.69 \]
Calc by: FJC

AquaClimb

11/24/2009

Checked by:

Gary K. Munkelt & Associates – Structural Engineers

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Fa = \left(1 - \frac{(KL/r)^2}{(2 + Cc^2)}\right) + \frac{F_y}{FS} = (1 - \frac{70.69}{(2 + 119.63^2)}) + \frac{40.0}{1.862} = 17.727 \text{ ksi}

Major Axis:

F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi}

Minor Axis:

F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi}

**Design Member 5, climber, Major Bending**

Tensile Bending Stress:

\( f_b \leq F_b, 2.725 \leq 26.4 \text{ OK 90\% under} \)

Compressive Bending Stress:

\( f_b \leq F_b, 2.725 \leq 26.4 \text{ OK 90\% under} \)

**Design Member 5, climber, Major Shear**

\( f_s \leq F_s, 0.07 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 5, climber, Minor Bending**

Tensile Bending Stress:

\( f_b \leq F_b, 0.399 \leq 26.4 \text{ OK 98\% under} \)

Compressive Bending Stress:

\( f_b \leq F_b, 0.399 \leq 26.4 \text{ OK 98\% under} \)

**Design Member 5, climber, Minor Shear**

\( f_s \leq F_s, 0.007 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 5, climber, Compression**

\( f_s \leq F_a, 0.0 \leq 17.727 \text{ OK 100\% under} \)

**Design Member 5, climber, Bending + Tension**

\( \frac{f_t}{F_t} + \frac{f_b}{F_b} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} = 0.325/24.0 + 2.725/26.4 + 0.399/26.4 = 0.132 \leq 1 \text{ OK 87\% under} \)

**Design Member 5, climber, Bending + Compression**

\( \frac{f_a}{F_a} = 0.0/17.727 = 0.0 \leq 0.15 : \phi_0 \)

\( \phi_a + \phi_b + \phi_{bx} + \phi_{by} = 0.0/17.727 + 2.725/26.4 + 0.399/26.4 = 0.118 \leq 1 \text{ OK 88\% under} \)

**Load Case: wind on back**

\( F_y = 40.0 \text{ ksi} \)

On gross area \( f_t \leq F_t, 0.6 \leq 40.0 = 24.0 \text{ OK 100\% under} \)

On net area \( f_t \leq F_t, 0.5 \leq 44.0 \text{ OK 99\% under} \)

\( F_y = 0.4 \cdot F_x = 0.4 \cdot 88.0 = 44.0 \text{ ksi} \)

\( K_l/l = \max(K_x l/l_x, K_y l/l_y) = \max(1.0 + 41.425/0.586, 1.0 + 41.425/0.586) = 70.69 \)

\( F_a = (1 - \frac{(KL/r)^2}{(2 + Cc^2)}) + \frac{F_y}{FS} = (1 - \frac{70.69}{(2 + 119.63^2)}) + \frac{40.0}{1.862} = 17.727 \text{ ksi} \)

Major Axis:

\( F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \)

Minor Axis:

\( F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \)

**Design Member 5, wind on back, Major Bending**

Tensile Bending Stress:

\( f_b \leq F_b, 3.645 \leq 26.4 \text{ OK 86\% under} \)

Compressive Bending Stress:

\( f_b \leq F_b, 3.645 \leq 26.4 \text{ OK 86\% under} \)

**Design Member 5, wind on back, Major Shear**

\( f_s \leq F_s, 0.072 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 5, wind on back, Minor Bending**

Tensile Bending Stress:

\( f_b \leq F_b, 0.159 \leq 26.4 \text{ OK 99\% under} \)

Compressive Bending Stress:

\( f_b \leq F_b, 0.159 \leq 26.4 \text{ OK 99\% under} \)

**Design Member 5, wind on back, Minor Shear**

\( f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 5, wind on back, Tension**

On gross area \( f_t \leq F_t, 2.456 \leq 24.0 \text{ OK 90\% under} \)
On net area $f_t \leq F_t$, 2.456 ≤ 44.0 OK 94% under

**Design Member 5, wind on back, Compression**

$f_a \leq F_a$, 0.0 ≤ 17.727 OK 100% under

**Design Member 5, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 2.456/24.0 + 3.645/26.4 + 0.159/26.4 = 0.246 \leq 1$ OK 75% under

**Design Member 5, wind on back, Bending + Compression**

$f_a/F_a = 0.0/17.727 = 0.0 \leq 0.15 \therefore \phi$

$\phi_a/\Phi_a + \phi_{\beta z}/\Phi_{\beta z} + \phi_{\beta y}/\Phi_{\beta y} = 0.0/17.727 + 3.645/26.4 + 0.159/26.4 = 0.144 \leq 1$ OK 86% under
Checking design member 6 (Column)

Members: 6  
Group: Custom1  
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front  

- **F_y** = 40.0 ksi  
  - On gross area: \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \) ksi  
  - On net area: \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \) ksi  
  - \( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \) ksi  
  - \( K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 26.5/0.586, 1.0 \times 26.5/0.586) = 45.222 \)

**Major Axis:**  
- \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \) ksi  

**Minor Axis:**  
- \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \) ksi

### Design Member 6, wind on front, Major Bending

- Tensile Bending Stress:  
  - \( f_b \leq F_b, 0.111 \leq 26.4 \) OK 100% under  
- Compressive Bending Stress:  
  - \( f_b \leq F_b, 0.111 \leq 26.4 \) OK 100% under

### Design Member 6, wind on front, Major Shear

- \( f_v \leq F_v, 0.004 \leq 16.0 \) OK 100% under

### Design Member 6, wind on front, Minor Bending

- Tensile Bending Stress:  
  - \( f_b \leq F_b, 3.875 \leq 26.4 \) OK 85% under  
- Compressive Bending Stress:  
  - \( f_b \leq F_b, 3.875 \leq 26.4 \) OK 85% under

### Design Member 6, wind on front, Minor Shear

- \( f_v \leq F_v, 0.178 \leq 16.0 \) OK 99% under

### Design Member 6, wind on front, Tension

- On gross area: \( f_t \leq F_t, 0.0 \leq 24.0 \) OK 100% under  
- On net area: \( f_t \leq F_t, 0.0 \leq 44.0 \) OK 100% under

### Design Member 6, wind on front, Compression

- \( f_a \leq F_a, 0.0 \leq 20.615 \) OK 100% under

### Design Member 6, wind on front, Bending + Tension

- \( f_y/F_y + f_b/F_b + f_v/F_v = 0.0/44.0 + 0.111/26.4 + 3.875/26.4 = 0.151 \leq 1 \) OK 85% under

### Design Member 6, wind on front, Bending + Compression

- \( f_y/F_y = 0.0/20.615 = 0.0 \leq 0.15 \) under  
- \( f_a/F_a = 0.0/20.615 + 0.111/26.4 + 3.875/26.4 = 0.151 \leq 1 \) OK 85% under

### Load Case: climber

- **F_y** = 40.0 ksi  
  - On gross area: \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \) ksi  
  - On net area: \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \) ksi  
  - \( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \) ksi  
  - \( K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 26.5/0.586, 1.0 \times 26.5/0.586) = 45.222 \)
\( F_a = (1 - (KL/r)^2/(2+Cc^2)) \cdot F_y / FS = (1 - 45.222^2/(2+119.63^2)) \cdot 40.0 / 1.802 = 20.615 \text{ ksi} \)

**Major Axis:**
\( F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \)

**Minor Axis:**
\( F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \)

**Design Member 6, climber, Major Bending**
- Tensile Bending Stress: \( f_b \leq F_b, 0.027 \leq 26.4 \text{ OK 100\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 0.027 \leq 26.4 \text{ OK 100\% under} \)

**Design Member 6, climber, Major Shear**
\( f_s \leq F_s, 0.001 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 6, climber, Minor Bending**
- Tensile Bending Stress: \( f_b \leq F_b, 0.0 \leq 26.4 \text{ OK 100\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 0.0 \leq 26.4 \text{ OK 100\% under} \)

**Design Member 6, climber, Minor Shear**
\( f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 6, climber, Compression**
\( f_s \leq F_s, 0.0 \leq 20.615 \text{ OK 100\% under} \)

**Design Member 6, climber, Bending + Tension**
\( f_b / F_b + f_t / F_t + f_b / F_b + f_t / F_t = 0.0 / 24.0 + 0.027 / 26.4 + 0.0 / 24.0 + 0.027 / 26.4 = 0.001 \leq 1 \text{ OK 100\% under} \)

**Design Member 6, climber, Bending + Compression**
\( f_b / F_b = 0.0 / 20.615 = 0.0 \leq 0.15 \cdot \phi \)
\( \phi_a / \phi_b + \phi_{by} / \phi_{by} + \phi_{by} / \phi_{by} = 0.0 / 20.615 + 0.027 / 26.4 + 0.0 / 24.0 + 0.027 / 26.4 = 0.001 \leq 1 \text{ OK 100\% under} \)

**Load Case: wind on back**
\( F_y = 40.0 \text{ ksi} \)
- On gross area: \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100\% under} \)
- On net area: \( f_t \leq F_t, 0.0 \leq 44.0 \text{ OK 100\% under} \)

**Design Member 6, climber, Compression**
\( f_s \leq F_s, 0.0 \leq 20.615 \text{ OK 100\% under} \)

**Design Member 6, climber, Bending + Tension**
\( f_b / F_b + f_t / F_t + f_b / F_b + f_t / F_t = 0.0 / 24.0 + 0.027 / 26.4 + 0.0 / 24.0 + 0.027 / 26.4 = 0.001 \leq 1 \text{ OK 100\% under} \)

**Design Member 6, climber, Bending + Compression**
\( f_b / F_b = 0.0 / 20.615 = 0.0 \leq 0.15 \cdot \phi \)
\( \phi_a / \phi_b + \phi_{by} / \phi_{by} + \phi_{by} / \phi_{by} = 0.0 / 20.615 + 0.027 / 26.4 + 0.0 / 24.0 + 0.027 / 26.4 = 0.001 \leq 1 \text{ OK 100\% under} \)

**Load Case: wind on back**
\( F_y = 40.0 \text{ ksi} \)
- On gross area: \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100\% under} \)
- On net area: \( f_t \leq F_t, 0.0 \leq 44.0 \text{ OK 100\% under} \)

**Design Member 6, climber, Compression**
\( f_s \leq F_s, 0.0 \leq 20.615 \text{ OK 100\% under} \)

**Design Member 6, climber, Bending + Tension**
\( f_b / F_b + f_t / F_t + f_b / F_b + f_t / F_t = 0.0 / 24.0 + 0.027 / 26.4 + 0.0 / 24.0 + 0.027 / 26.4 = 0.001 \leq 1 \text{ OK 100\% under} \)

**Design Member 6, climber, Bending + Compression**
\( f_b / F_b = 0.0 / 20.615 = 0.0 \leq 0.15 \cdot \phi \)
\( \phi_a / \phi_b + \phi_{by} / \phi_{by} + \phi_{by} / \phi_{by} = 0.0 / 20.615 + 0.027 / 26.4 + 0.0 / 24.0 + 0.027 / 26.4 = 0.001 \leq 1 \text{ OK 100\% under} \)
On net area $f_t \leq F_t$, 0.0 \leq 44.0$ OK 100% under

**Design Member 6, wind on back, Compression**

$f_a \leq F_a$, 0.0 \leq 20.615$ OK 100% under

**Design Member 6, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/24.0 + 0.111/26.4 + 3.875/26.4 = 0.151 \leq 1$ OK 85% under

**Design Member 6, wind on back, Bending + Compression**

$f_a/F_a = 0.0/20.615 = 0.0 \leq 0.15 \therefore \phi_0$

$\phi_a/\Phi_a + \phi_{bx}/\Phi_{bx} + \phi_{by}/\Phi_{by} = 0.0/20.615 + 0.111/26.4 + 3.875/26.4 = 0.151 \leq 1$ OK 85% under
Checking design member 7

Members: 7
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 28.5/0.586, 1.0 \times 28.5/0.586) = 48.635 \]

\[ F_a = \left(1 - \frac{K_l/r}{2} \right)^2 \times F_y / FS = \left(1 - \frac{48.635}{2 \times 119.63} \right)^2 \times 40.0 / 1.811 = 20.265 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 7, wind on front, Major Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100% under} \]

**Design Member 7, wind on front, Major Shear**

\[ f_v \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 7, wind on front, Minor Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100% under} \]

**Design Member 7, wind on front, Minor Shear**

\[ f_v \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 7, wind on front, Tension**

- On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100% under} \)

- On net area \( f_t \leq F_t, \ 0.0 \leq 44.0 \text{ OK 100% under} \)

**Design Member 7, wind on front, Compression**

\[ f_a \leq F_a, \ 0.0 \leq 20.265 \text{ OK 100% under} \]

**Design Member 7, wind on front, Bending + Tension**

\[ f_a / F_a + f_b / F_b + f_v / F_v = 0.0/44.0 + 0.0/24.0 + 0.0/26.4 \leq 1 \text{ OK 100% under} \]

**Design Member 7, wind on front, Bending + Compression**

\[ f_a / F_a = 0.0/20.265 = 0.0 \leq 0.15 \implies \phi \]

\[ \phi_a = \frac{F_a}{F} \]

**Load Case: climber**

\[ F_y = 40.0 \text{ ksi} \]

- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 28.5/0.586, 1.0 \times 28.5/0.586) = 48.635 \]
Calc by: FJC

AquaClimb

11/24/2009

Checked by:

– S T R U C T U R A L  E N G I N E E R S

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\[
F_a = \frac{(1-(KL/r)^2(2+Cc^2))^2}{2}\cdot F_y / FS = \frac{(1-48.635^2/(2+119.63^2))}{2} = 20.265 \text{ ksi}
\]

**Major Axis:**

\[
F_b = 0.66\cdot F_y = 0.66\cdot 40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**

\[
F_b = 0.66\cdot F_y = 0.66\cdot 40.0 = 26.4 \text{ ksi}
\]

**Design Member 7, climber, Major Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]

**Design Member 7, climber, Major Shear**

\[ f_s \leq F_s, \quad 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 7, climber, Minor Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]

**Design Member 7, climber, Minor Shear**

\[ f_s \leq F_v, \quad 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 7, climber, Tension**

- On gross area \[ f_t \leq F_t, \quad 0.0 \leq 24.0 \text{ OK 100% under} \]
- On net area \[ f_t \leq F_u, \quad 0.0 \leq 44.0 \text{ OK 100% under} \]

**Design Member 7, climber, Compression**

\[ f_a \leq F_a, \quad 0.0 \leq 20.265 \text{ OK 100% under} \]

**Design Member 7, climber, Bending + Tension**

\[
\frac{f_a}{F_a} + \frac{f_b}{F_b} + \frac{f_t}{F_t} + \frac{f_v}{F_v} = 0.0/44.0 + 0.0/26.4 + 0.0/26.4 = 0.0 \leq 1 \text{ OK 100% under}
\]

**Design Member 7, climber, Bending + Compression**

\[
\frac{f_a}{F_a} = 0.0/20.265 = 0.0 \leq 0.15 : \phi_0
\]

\[
\phi_a/\phi_a + \phi_b/\phi_b + \phi_t/\phi_t + \phi_v/\phi_v = 0.0/20.265 + 0.0/26.4 + 0.0/26.4 = 0.0 \leq 1 \text{ OK 100% under}
\]

**Load Case: wind on back**

\[ F_y = 40.0 \text{ ksi} \]

- On gross area \[ F_t = 0.6\cdot F_y = 0.6\cdot 40.0 = 24.0 \text{ ksi} \]
- On net area \[ F_t = 0.5\cdot F_u = 0.5\cdot 88.0 = 44.0 \text{ ksi} \]

\[ K_l/r = \max(K_x/l/r_x, K_y/l/r_y) = \max(1.0*28.5/0.586, 1.0*28.5/0.586) = 48.635 \]

\[
F_a = \frac{(1-(KL/r)^2(2+Cc^2))^2}{2}\cdot F_y / FS = \frac{(1-48.635^2/(2+119.63^2))}{2} = 20.265 \text{ ksi}
\]

**Major Axis:**

\[
F_b = 0.66\cdot F_y = 0.66\cdot 40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**

\[
F_b = 0.66\cdot F_y = 0.66\cdot 40.0 = 26.4 \text{ ksi}
\]

**Design Member 7, wind on back, Major Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]

**Design Member 7, wind on back, Major Shear**

\[ f_s \leq F_s, \quad 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 7, wind on back, Minor Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]

**Design Member 7, wind on back, Minor Shear**

\[ f_s \leq F_v, \quad 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 7, wind on back, Tension**

- On gross area \[ f_t \leq F_t, \quad 0.0 \leq 24.0 \text{ OK 100% under} \]
On net area $f_t \leq F_t, 0.0 \leq 44.0$ OK 100% under

**Design Member 7, wind on back, Compression**
$f_a \leq F_a, 0.0 \leq 20.265$ OK 100% under

**Design Member 7, wind on back, Bending + Tension**
\[ \frac{f_a}{F_t} + \frac{f_{bx}}{F_{bx} + f_{by}} = 0.0/44.0 + 0.0/26.4 + 0.0/26.4 = 0.0 \leq 1 \text{ OK 100\% under} \]

**Design Member 7, wind on back, Bending + Compression**
\[ \frac{f_a}{F_a} = 0.0/20.265 = 0.0 \leq 0.15 \quad \therefore \phi = 0 \]

\[ \phi_a + \phi_{a\xi} + \phi_{a\xi} + \phi_{a\psi} = 0.0/20.265 + 0.0/26.4 + 0.0/26.4 = 0.0 \leq 1 \text{ OK 100\% under} \]
Checking design member 8
Members: 8
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front
- \( F_y = 40.0 \text{ ksi} \)
  - On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
  - On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
- \( F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)
- \( K_{lr} = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 16.279/0.586, 1.0 \times 16.279/0.586) = 27.78 \)
- \( F_a = (1 - (K_{lr}^2/(2+C^2)) \times F_y/F_S = (1 - 27.78^2/(2+119.63^2)) \times 40.0/1.752 = 22.21 \text{ ksi} \)
  - Major Axis: \( f_b \leq F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)
  - Minor Axis: \( f_b \leq F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

Design Member 8, wind on front, Major Bending
- Tensile Bending Stress: \( f_b \leq F_b, 7.927 \leq 26.4 \text{ OK 70% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 7.927 \leq 26.4 \text{ OK 70% under} \)

Design Member 8, wind on front, Major Shear
- \( f_v \leq F_v, 0.081 \leq 16.0 \text{ OK 99% under} \)

Design Member 8, wind on front, Minor Bending
- Tensile Bending Stress: \( f_b \leq F_b, 1.798 \leq 26.4 \text{ OK 93% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 1.798 \leq 26.4 \text{ OK 93% under} \)

Design Member 8, wind on front, Minor Shear
- \( f_v \leq F_v, 0.162 \leq 16.0 \text{ OK 99% under} \)

Design Member 8, wind on front, Tension
- On gross area \( f_t \leq F_t, 0.177 \leq 24.0 \text{ OK 99% under} \)
- On net area \( f_t \leq F_t, 0.177 \leq 44.0 \text{ OK 100% under} \)

Design Member 8, wind on front, Compression
- \( f_a \leq F_a, 0.0 \leq 22.213 \text{ OK 100% under} \)

Design Member 8, wind on front, Bending + Tension
- \( f_y/F_t + f_b/F_t + f_v/F_t = 0.177/24.0 + 7.927/26.4 + 1.798/26.4 = 0.376 \leq 1 \text{ OK 62% under} \)

Design Member 8, wind on front, Bending + Compression
- \( f_v/F_a = 0.0/22.213 = 0.0 \leq 0.15 \therefore \phi = 0 \)

Load Case: climber
- \( F_y = 40.0 \text{ ksi} \)
  - On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
  - On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
- \( F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)
- \( K_{lr} = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 16.279/0.586, 1.0 \times 16.279/0.586) = 27.78 \)
\[ F_a = (1 - (KL/r)^2/(2+Cc^2)) \cdot F_y/FS = (1 - 27.78^2/(2+119.63^2)) \cdot 40.0/1.752 = 22.213 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Design Member 8, climber, Major Bending**

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 2.0 \leq 26.4 \ \text{OK 92\% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \ 2.0 \leq 26.4 \ \text{OK 92\% under} \]

**Design Member 8, climber, Major Shear**

\[ f_v \leq F_v, \ 0.095 \leq 16.0 \ \text{OK 99\% under} \]

**Design Member 8, climber, Minor Bending**

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 0.325 \leq 26.4 \ \text{OK 99\% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \ 0.325 \leq 26.4 \ \text{OK 99\% under} \]

**Design Member 8, climber, Minor Shear**

\[ f_v \leq F_v, \ 0.035 \leq 16.0 \ \text{OK 100\% under} \]

**Design Member 8, climber, Tension**

- **On gross area:**
  \[ f_t \leq F_t, \ 0.0 \leq 24.0 \ \text{OK 99\% under} \]

- **On net area:**
  \[ f_t \leq F_t, \ 0.0 \leq 44.0 \ \text{OK 100\% under} \]

**Design Member 8, climber, Compression**

\[ f_a \leq F_a, \ 0.047 \leq 22.213 \ \text{OK 100\% under} \]

**Design Member 8, climber, Bending + Tension**

\[ \frac{f_a}{F_t} + \frac{f_b}{F_b} + \frac{f_v}{F_v} = 0.047/22.213 + 0.0/26.4 + 0.081/16.0 = 0.088 \leq 1 \ \text{OK 91\% under} \]

**Load Case: wind on back**

\[ F_y = 40.0 \ \text{ksi} \]

- **On gross area:**
  \[ F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \ \text{ksi} \]

- **On net area:**
  \[ F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \ \text{ksi} \]

\[ KL/r = max(K_x l/r_x, K_y l/r_y) = max(1.0 \cdot 16.279/0.586, 1.0 \cdot 16.279/0.586) = 27.78 \]

\[ F_a = (1 - (KL/r)^2/(2+Cc^2)) \cdot F_y/FS = (1 - 27.78^2/(2+119.63^2)) \cdot 40.0/1.752 = 22.213 \ \text{ksi} \]

**Major Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \ \text{ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \ \text{ksi} \]

**Design Member 8, wind on back, Major Bending**

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 7.927 \leq 26.4 \ \text{OK 70\% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \ 7.927 \leq 26.4 \ \text{OK 70\% under} \]

**Design Member 8, wind on back, Major Shear**

\[ f_v \leq F_v, \ 0.081 \leq 16.0 \ \text{OK 99\% under} \]

**Design Member 8, wind on back, Minor Bending**

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 1.798 \leq 26.4 \ \text{OK 93\% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \ 1.798 \leq 26.4 \ \text{OK 93\% under} \]

**Design Member 8, wind on back, Minor Shear**

\[ f_v \leq F_v, \ 0.162 \leq 16.0 \ \text{OK 99\% under} \]

**Design Member 8, wind on back, Tension**

- **On gross area:**
  \[ f_t \leq F_t, \ 0.0 \leq 24.0 \ \text{OK 100\% under} \]
On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 8, wind on back, Compression**

$f_a \leq F_a$, $0.177 \leq 22.213$ OK 99% under

**Design Member 8, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 7.927/26.4 + 1.798/26.4 = 0.368 \leq 1$ OK 63% under

**Design Member 8, wind on back, Bending + Compression**

$f_a/F_a = 0.177/22.213 = 0.008 \leq 0.15$ \(\therefore \Phi = 0.008 \leq 0.15 \Phi\)

\[
\Phi_{\alpha} + \Phi_{\beta} + \Phi_{\gamma} = 0.177/22.213 + 7.927/26.4 + 1.798/26.4 = 0.376 \leq 1 \text{ OK 62% under}
\]
Checking design member 9

Members: 9
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

- On gross area: \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area: \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_y = 40.0 \]

\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

\[ F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

**Design Member 9, wind on front, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 13.996 \leq 26.4 \text{ OK 47% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 13.996 \leq 26.4 \text{ OK 47% under} \]

**Design Member 9, wind on front, Major Shear**

\[ f_v \leq F_v, \quad 0.299 \leq 16.0 \text{ OK 98% under} \]

**Design Member 9, wind on front, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 2.844 \leq 26.4 \text{ OK 89% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 2.844 \leq 26.4 \text{ OK 89% under} \]

**Design Member 9, wind on front, Minor Shear**

\[ f_v \leq F_v, \quad 0.083 \leq 16.0 \text{ OK 99% under} \]

**Design Member 9, wind on front, Tension**

- On gross area: \( f_t \leq F_t, \quad 0.0 \leq 24.0 \text{ OK 100% under} \)
- On net area: \( f_t \leq F_t, \quad 0.0 \leq 44.0 \text{ OK 100% under} \)

**Design Member 9, wind on front, Compression**

\[ f_a \leq F_a, \quad 2.585 \leq 13.266 \text{ OK 81% under} \]

**Design Member 9, wind on front, Bending + Tension**

\[ f_y/F_y+F_b/F_b+F_v/F_v=0.0/44.0+13.996/26.4+2.844/26.4=0.638 \leq 1 \text{ OK 36% under} \]

**Design Member 9, wind on front, Bending + Compression**

Axial Ratio: \( f_a/F_a = 2.585/13.266 = 0.195 \)

Major Ratio: \( C_{mx}/(1-f_a/F_a)-F_{bx} = 1.0 \times 13.996/(1-2.585/14.225) = 26.4 \)

Minor Ratio: \( C_{my}/(1-f_a/F_a)-F_{by} = 1.0 \times 2.844/(1-2.585/14.225) = 26.4 \)

Axial Ratio + Major Ratio + Minor Ratio: \( 0.195 + 0.648 + 0.132 = 1 \text{ OK 3% under} \)

**Design Member 9, wind on front, Tension**

\[ F_y = 40.0 \text{ ksi} \]

- On gross area: \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area: \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
Calc by: FJC  AquaClimb  11/24/2009

Checked by:

Gary K. Munkelt & Associates – Structural Engineers

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\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x l/r, K_y l/r) = \max(1.0 \times 60.042 / 0.586, 1.0 \times 60.042 / 0.586) = 102.46 \]

\[ F_a = (1 - (KL/r)^2)(2 + Cc^2) + F_y = (1 - 102.46^2)(2 + 119.63^2) \times 40.0 / 1.909 = 13.266 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 9, climber, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \ 2.63 \leq 26.4 \text{ OK 90}\% \text{ under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \ 2.63 \leq 26.4 \text{ OK 90}\% \text{ under} \]

**Design Member 9, climber, Major Shear**

\[ f_v \leq F_v, \ 0.045 \leq 16.0 \text{ OK 100}\% \text{ under} \]

**Design Member 9, climber, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \ 0.406 \leq 26.4 \text{ OK 98}\% \text{ under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \ 0.406 \leq 26.4 \text{ OK 98}\% \text{ under} \]

**Design Member 9, climber, Minor Shear**

\[ f_v \leq F_v, \ 0.012 \leq 16.0 \text{ OK 100}\% \text{ under} \]

**Design Member 9, climber, Tension**

On gross area \( f_t \leq F_t, \ 0.36 \leq 24.0 \text{ OK 99}\% \text{ under} \)

On net area \( f_t \leq F_t, \ 0.36 \leq 44.0 \text{ OK 99}\% \text{ under} \)

**Design Member 9, climber, Compression**

\[ f_a \leq F_a, \ 0.0 \leq 13.266 \text{ OK 100}\% \text{ under} \]

**Design Member 9, climber, Bending + Tension**

\[ \frac{f_a}{F_t} + \frac{f_b}{F_b} + \frac{f_v}{F_y} = 0.36 / 24.0 + 2.63 / 26.4 + 0.406 / 26.4 = 0.13 \leq 1 \text{ OK 87}\% \text{ under} \]

**Design Member 9, climber, Bending + Compression**

\[ \frac{f_a}{F_a} = 0.0 / 13.266 = 0.0 \leq 0.15 \]

\[ \phi_a/\phi_a + \phi_b/\phi_b + \phi_v/\phi_v = 0.0 / 13.266 + 2.63 / 26.4 + 0.406 / 26.4 = 0.115 \leq 1 \text{ OK 89}\% \text{ under} \]

**Load Case: wind on back**

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( f_t \leq F_t, \ 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( f_t \leq F_t, \ 0.5 \times F_y = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x l/r, K_y l/r) = \max(1.0 \times 60.042 / 0.586, 1.0 \times 60.042 / 0.586) = 102.46 \]

\[ F_a = (1 - (KL/r)^2)(2 + Cc^2) + F_y = (1 - 102.46^2)(2 + 119.63^2) \times 40.0 / 1.909 = 13.266 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 9, wind on back, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \ 13.996 \leq 26.4 \text{ OK 47}\% \text{ under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \ 13.996 \leq 26.4 \text{ OK 47}\% \text{ under} \]

**Design Member 9, wind on back, Major Shear**

\[ f_v \leq F_v, \ 0.299 \leq 16.0 \text{ OK 98}\% \text{ under} \]

**Design Member 9, wind on back, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \ 2.844 \leq 26.4 \text{ OK 89}\% \text{ under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \ 2.844 \leq 26.4 \text{ OK 89}\% \text{ under} \]

**Design Member 9, wind on back, Minor Shear**
\( f_v \leq F_v \), \( 0.083 \leq 16.0 \) OK 99\% under

**Design Member 9, wind on back, Tension**
- On gross area \( f_t \leq F_t \), \( 2.585 \leq 24.0 \) OK 89\% under
- On net area \( f_t \leq F_t \), \( 2.585 \leq 44.0 \) OK 94\% under

**Design Member 9, wind on back, Compression**
- \( f_a \leq F_a \), \( 0.0 \leq 13.266 \) OK 100\% under

**Design Member 9, wind on back, Bending + Tension**
- \( f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 2.585/24.0 + 13.996/26.4 + 2.844/26.4 = 0.746 \leq 1 \) OK 25\% under

**Design Member 9, wind on back, Bending + Compression**
- \( f_a/F_a = 0.0/13.266 = 0.0 \leq 0.15 \therefore \phi_0 \)
- \( \phi_0 = 0.0/13.266 + 13.996/26.4 + 2.844/26.4 = 0.638 \leq 1 \) OK 36\% under
Checking design member 10

Members: 10
Group: Custom1
Section: 1/2" diameter bar

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\( K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 8.0/0.125, 1.0 \times 8.0/0.125) = 64.0 \)

\[ F_a = (1 - (KL/r)^2/(2 \times C_{Cc}^2)) \times F_y/FS = (1 - 64.0^2/(2 \times 119.63^2)) \times 40.0/1.848 = 18.546 \text{ ksi} \]

Major Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Major Axis:
\[ F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

Design Member 10, wind on front, Major Bending

Tensile Bending Stress:
\( f_b \leq F_b, \ 0.218 \leq 26.4 \text{ OK 99\% under} \)

Compressive Bending Stress:
\( f_b \leq F_b, \ 0.218 \leq 26.4 \text{ OK 99\% under} \)

Design Member 10, wind on front, Major Shear
\( f_s \leq F_s, \ 0.0 \leq 16.0 \text{ OK 100\% under} \)

Design Member 10, wind on front, Minor Bending

Tensile Bending Stress:
\( f_b \leq F_b, \ 7.243 \leq 30.0 \text{ OK 76\% under} \)

Compressive Bending Stress:
\( f_b \leq F_b, \ 7.243 \leq 30.0 \text{ OK 76\% under} \)

Design Member 10, wind on front, Minor Shear
\( f_s \leq F_s, \ 0.136 \leq 16.0 \text{ OK 99\% under} \)

Design Member 10, wind on front, Tension

On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100\% under} \)

On net area \( f_t \leq F_t, \ 0.0 \leq 44.0 \text{ OK 100\% under} \)

Design Member 10, wind on front, Compression
\( f_b \leq F_b, \ 0.133 \leq 18.546 \text{ OK 99\% under} \)

Design Member 10, wind on front, Bending + Tension
\( \frac{F_y/F_t}{F_{tx} + F_{ty} + F_{dy}/F_{dy}} = 0.0/44.0 + 0.218/26.4 + 7.243/30.0 = 0.25 \leq 1 \text{ OK 75\% under} \)

Design Member 10, wind on front, Bending + Compression
\( \frac{F_a}{F_{a} \times \Phi_{a} + \Phi_{b} + \Phi_{c} + \Phi_{d} + \Phi_{e} + \Phi_{f} + \Phi_{g} + \Phi_{h}} = 0.133/18.546 + 0.218/26.4 + 7.243/30.0 = 0.257 \leq 1 \text{ OK 74\% under} \)

Load Case: climber

\( F_y = 40.0 \text{ ksi} \)

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\( K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 8.0/0.125, 1.0 \times 8.0/0.125) = 64.0 \)
\[ F_a = (1 - (KL/r)^2/(2+Cc^2)) \times F_y / FS = (1-64.0^2/(2+119.63^2)) \times 40.0 / 1.848 = 18.546 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

**Design Member 10, climber, Major Bending**
- Tensile Bending Stress: \( f_b \leq F_b, 0.202 \leq 26.4 \text{ OK 99\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 0.202 \leq 26.4 \text{ OK 99\% under} \)

**Design Member 10, climber, Major Shear**
\( f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 10, climber, Minor Bending**
- Tensile Bending Stress: \( f_b \leq F_b, 4.391 \leq 30.0 \text{ OK 85\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 4.391 \leq 30.0 \text{ OK 85\% under} \)

**Design Member 10, climber, Minor Shear**
\( f_s \leq F_s, 0.056 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 10, climber, Tension**
- On gross area \( f_t \leq F_t, 0.04 \leq 24.0 \text{ OK 100\% under} \)
- On net area \( f_t \leq F_t, 0.04 \leq 44.0 \text{ OK 100\% under} \)

**Design Member 10, climber, Compression**
\( f_s \leq F_s, 0.0 \leq 18.546 \text{ OK 100\% under} \)

**Design Member 10, climber, Bending + Tension**
\[ f_t/F_t + f_y/F_y = 0.04/24.0 + 0.202/26.4 + 4.391/30.0 = 0.156 \leq 1 \text{ OK 84\% under} \]

**Design Member 10, climber, Bending + Compression**
\[ f_s/F_s = 0.0/18.546 = 0.0 \leq 0.15 : \phi_0 \]
\[ \phi_0 = \phi_0 + \phi_1 + \phi_2 + \phi_3 = 0.0 \times 18.546 + 0.202/26.4 + 4.391/30.0 = 0.154 \leq 1 \text{ OK 85\% under} \]

**Load Case: wind on back**
\( F_y = 40.0 \text{ ksi} \)
- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( K_l/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 8.0/0.125, 1.0 \times 8.0/0.125) = 64.0 \)

\[ F_a = (1 - (KL/r)^2/(2+Cc^2)) \times F_y / FS = (1-64.0^2/(2+119.63^2)) \times 40.0 / 1.848 = 18.546 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

**Design Member 10, wind on back, Major Bending**
- Tensile Bending Stress: \( f_b \leq F_b, 0.218 \leq 26.4 \text{ OK 99\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 0.218 \leq 26.4 \text{ OK 99\% under} \)

**Design Member 10, wind on back, Major Shear**
\( f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 10, wind on back, Minor Bending**
- Tensile Bending Stress: \( f_b \leq F_b, 7.243 \leq 30.0 \text{ OK 76\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 7.243 \leq 30.0 \text{ OK 76\% under} \)

**Design Member 10, wind on back, Minor Shear**
\( f_s \leq F_s, 0.136 \leq 16.0 \text{ OK 99\% under} \)

**Design Member 10, wind on back, Tension**
- On gross area \( f_t \leq F_t, 0.133 \leq 24.0 \text{ OK 99\% under} \)
On net area $f_i \leq F_t$, $0.133 \leq 44.0$ OK 100% under

**Design Member 10, wind on back, Compression**

\[ f_a \leq F_a, \quad 0.0 \leq 18.546 \text{ OK 100\% under} \]

**Design Member 10, wind on back, Bending + Tension**

\[
\frac{f_a}{F_t} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} = \frac{0.133}{24.0} + 0.218/26.4 + 7.243/30.0 = 0.255 \leq 1 \text{ OK 74\% under} \]

**Design Member 10, wind on back, Bending + Compression**

\[
\frac{f_a}{F_a} = \frac{0.0}{18.546} = 0.0 \leq 0.15 \therefore \phi_0
\]

\[
\phi_{\alpha} = \phi_{\beta_x} + \phi_{\beta_y} = \phi_{\beta_y} = \frac{0.0/18.546 + 0.218/26.4 + 7.243/30.0 - 0.25 \leq 1 \text{ OK 75\% under}}{\phi_{\alpha} + \phi_{\beta_x} + \phi_{\beta_y}}
\]
Checking design member 11

Members: 11
Group: Custom1
Section: 1/4 x 2 link

Load Case: wind on front

\( F_y = 40.0 \text{ ksi} \)

- On gross area \( F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \)

\( F_v = 0.4 \cdot F_y = 0.4 \cdot 40.0 = 16.0 \text{ ksi} \)

\( K_{l/r} = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 9.0/0.577, 0.65 \cdot 9.0/0.072) = 81.06 \)

\( F_{a} = (1 - (K_{l/r})^2/(2 \cdot Cc)^2) \cdot F_y / FS = (1 - 81.06^2/(2 \cdot 117.548)^2) \cdot 40.0 / 1.884 = 16.181 \text{ ksi} \)

Major Axis:

- \( F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \)
- \( F_b = 0.75 \cdot F_y = 0.75 \cdot 40.0 = 30.0 \text{ ksi} \)

Design Member 11, wind on front, Major Bending

- Tensile Bending Stress: \( f_b \leq F_b \), 0.0 \( \leq 26.4 \) OK 100% under
- Compressive Bending Stress: \( f_b \leq F_b \), 0.0 \( \leq 26.4 \) OK 100% under

Design Member 11, wind on front, Major Shear

- Tensile Shear Stress: \( f_v \leq F_v \), 0.0 \( \leq 16.0 \) OK 100% under

Design Member 11, wind on front, Minor Bending

- Tensile Bending Stress: \( f_b \leq F_b \), 2.525 \( \leq 30.0 \) OK 92% under
- Compressive Bending Stress: \( f_b \leq F_b \), 2.525 \( \leq 30.0 \) OK 92% under

Design Member 11, wind on front, Minor Shear

- Tensile Shear Stress: \( f_v \leq F_v \), 0.018 \( \leq 16.0 \) OK 100% under

Design Member 11, wind on front, Tension

- On gross area \( f_t \leq F_t \), 0.0 \( \leq 24.0 \) OK 100% under
- On net area \( f_t \leq F_t \), 0.0 \( \leq 44.0 \) OK 100% under

Design Member 11, wind on front, Compression

- Tensile Stress: \( f_b \leq F_a \), 0.108 \( \leq 16.181 \) OK 99% under

Design Member 11, wind on front, Bending + Tension

\( f_y(F_t + f_bx + f_dy)/F_y = 0.0/44.0 + 0.0/26.4 + 2.525/30.0 = 0.084 \leq 1 \) OK 92% under

Design Member 11, wind on front, Bending + Compression

\( f_y/F_a = 0.108/16.181 = 0.007 \leq 0.15 \cdot \phi \)

\( \phi = \left( \frac{\phi_a + \phi_{b_t}}{C_{b_t}} + \phi_{b_y}/C_{b_y} \right) = 0.108/16.181 + 0.0/26.4 + 2.525/30.0 = 0.091 \leq 1 \) OK 91% under

Load Case: climber

\( F_y = 40.0 \text{ ksi} \)

- On gross area \( F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \)

\( K_{l/r} = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 9.0/0.577, 0.65 \cdot 9.0/0.072) = 81.06 \)
Calc by: FJC
AquaClimb

Checked by:
–  S T R U C T U R A L  E N G I N E E R S

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\[ F_a = (1 - (KL/r)^2/(2 + Cc^2)) \times F_y/FS = (1 - 81.06^2/(2 + 117.548^2)) \times 40.0/1.884 = 16.181 \text{ ksi} \]

**Major Axis:**
- \[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]
- \[ F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

**Design Member 11, climber, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \quad \text{OK 100\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \quad \text{OK 100\% under} \]

**Design Member 11, climber, Major Shear**
- \[ f_s \leq F_s, \quad 0.08 \leq 16.0 \quad \text{OK 100\% under} \]

**Design Member 11, climber, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 1.321 \leq 30.0 \quad \text{OK 96\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 1.321 \leq 30.0 \quad \text{OK 96\% under} \]

**Design Member 11, climber, Minor Shear**
- \[ f_s \leq F_s, \quad 0.008 \leq 16.0 \quad \text{OK 100\% under} \]

**Design Member 11, climber, Tension**
- On gross area \[ f_t \leq F_t, \quad 0.0 \leq 24.0 \quad \text{OK 100\% under} \]
- On net area \[ f_t \leq F_t, \quad 0.0 \leq 44.0 \quad \text{OK 100\% under} \]

**Design Member 11, climber, Compression**
- \[ f_a \leq F_a, \quad 0.022 \leq 16.181 \quad \text{OK 100\% under} \]

**Design Member 11, climber, Bending + Tension**
- \[ f_t/F_t + f_b/F_b + f_y/F_y = 0.0/44.0 + 0.0/26.4 + 1.321/30.0 = 0.044 \leq 1 \quad \text{OK 96\% under} \]

**Design Member 11, climber, Bending + Compression**
- \[ f_b/F_b = 0.022/16.181 = 0.001 \leq 0.15 : \phi_0 \]
- \[ \phi_u/\phi_d + \phi_p/\phi_b + \phi_y/\phi_y = 0.022/16.181 + 0.0/26.4 + 1.321/30.0 = 0.045 \leq 1 \quad \text{OK 95\% under} \]

**Load Case: wind on back**
- \[ F_y = 40.0 \quad \text{ksi} \]
- On gross area \[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \quad \text{ksi} \]
- On net area \[ F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \quad \text{ksi} \]
- \[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \quad \text{ksi} \]
- \[ KL/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 9.0/0.577, 0.65 \times 9.0/0.072) = 81.06 \]
- \[ F_a = (1 - (KL/r)^2/(2 + Cc^2)) \times F_y/FS = (1 - 81.06^2/(2 + 117.548^2)) \times 40.0/1.884 = 16.181 \quad \text{ksi} \]
- **Major Axis:**
  - \[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \quad \text{ksi} \]
  - \[ F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \quad \text{ksi} \]

**Design Member 11, wind on back, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \quad \text{OK 100\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 0.0 \leq 26.4 \quad \text{OK 100\% under} \]

**Design Member 11, wind on back, Major Shear**
- \[ f_s \leq F_s, \quad 0.0 \leq 16.0 \quad \text{OK 100\% under} \]

**Design Member 11, wind on back, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \quad 2.525 \leq 30.0 \quad \text{OK 92\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \quad 2.525 \leq 30.0 \quad \text{OK 92\% under} \]

**Design Member 11, wind on back, Minor Shear**
- \[ f_s \leq F_s, \quad 0.018 \leq 16.0 \quad \text{OK 100\% under} \]

**Design Member 11, wind on back, Tension**
- On gross area \[ f_t \leq F_t, \quad 0.108 \leq 24.0 \quad \text{OK 100\% under} \]
On net area $f_t \leq F_t$, 0.108 $\leq$ 44.0 OK 100% under

Design Member 11, wind on back, Compression
$f_a \leq F_a$, 0.0 $\leq$ 16.181 OK 100% under

Design Member 11, wind on back, Bending + Tension

$f_a/F_t + f_t/F_a + f_t/F_y = 0.108/24.0 + 0.0/26.4 + 2.525/30.0 = 0.089 \leq 1$ OK 91% under

Design Member 11, wind on back, Bending + Compression

$f_v/F_a = 0.0/16.181 = 0.0 \leq 0.15 \therefore \phi=0$

$\phi_\alpha/\Phi_\alpha + \phi_\beta/\Phi_\beta = 0.0/16.181 + 0.0/26.4 + 2.525/30.0 = 0.084 \leq 1$ OK 92% under
Checking design member 12

Members: 12
Group: Custom1
Section: 1/2" diameter bar

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area: 
\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area: 
\[ F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 4.0/0.125, 1.0 \times 4.0/0.125) = 32.0 \]

\[ F_a = (1 - (KL/r)^2/(2 \times Cc^2)) \times F_y / FS = (1 - 32.0^2/(2 \times 119.63^2)) \times 40.0/1.765 = 21.857 \text{ ksi} \]

Design Member 12, wind on front, Major Bending

Tensile Bending Stress:
\[ f_b \leq F_b, 0.411 \leq 26.4 \text{ OK 98\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 0.411 \leq 26.4 \text{ OK 98\% under} \]

Design Member 12, wind on front, Major Shear

\[ f_v \leq F_v, 0.0 \leq 16.0 \text{ OK 100\% under} \]

Design Member 12, wind on front, Minor Bending

Tensile Bending Stress:
\[ f_b \leq F_b, 8.437 \leq 30.0 \text{ OK 72\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 8.437 \leq 30.0 \text{ OK 72\% under} \]

Design Member 12, wind on front, Minor Shear

\[ f_v \leq F_v, 0.144 \leq 16.0 \text{ OK 99\% under} \]

Design Member 12, wind on front, Tension

On gross area:
\[ f_t \leq F_t, 0.062 \leq 24.0 \text{ OK 100\% under} \]

On net area:
\[ f_t \leq F_t, 0.062 \leq 44.0 \text{ OK 100\% under} \]

Design Member 12, wind on front, Compression

\[ f_a \leq F_a, 0.0 \leq 21.857 \text{ OK 100\% under} \]

Design Member 12, wind on front, Bending + Tension

\[ f_a/F_t + f_b/F_b + f_y/F_y = 0.062/24.0 + 0.411/26.4 + 8.437/30.0 = 0.299 \leq 1 \text{ OK 70\% under} \]

Design Member 12, wind on front, Bending + Compression

\[ f_a/F_a = 0.0/21.857 = 0.0 \leq 0.15 \Rightarrow \Phi \]

\[ \Phi_{\alpha} / \Phi_{\beta} / \Phi_{\gamma} / \Phi_{\beta} / \Phi_{\phi} = 0.0/0.021857 + 0.411/26.4 + 8.437/30.0 = 0.297 \leq 1 \text{ OK 70\% under} \]

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]

On gross area:
\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area:
\[ F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 4.0/0.125, 1.0 \times 4.0/0.125) = 32.0 \]
\[ F_a = \frac{(1 - (KL/r)^2/2Cc^2))F_y}{FS = (1 - 32.0^2/(2 \times 119.63^2))} = 40.0/1.765 = 21.857 \text{ ksi} \]

**Major Axis:**
- \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)
- \( F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \)

**Design Member 12, climber, Major Bending**
- Tensile Bending Stress: \( f_b \leq F_b, 0.221 \leq 26.4 \text{ OK 99 under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 0.221 \leq 26.4 \text{ OK 99 under} \)

**Design Member 12, climber, Major Shear**
- \( f_v \leq F_v, 0.0 \leq 16.0 \text{ OK 100 under} \)

**Design Member 12, climber, Minor Bending**
- Tensile Bending Stress: \( f_b \leq F_b, 9.338 \leq 30.0 \text{ OK 69 under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 9.338 \leq 30.0 \text{ OK 69 under} \)

**Design Member 12, climber, Minor Shear**
- \( f_v \leq F_v, 0.219 \leq 16.0 \text{ OK 99 under} \)

**Design Member 12, wind on back, Major Bending**
- Tensile Bending Stress: \( f_b \leq F_b, 0.411 \leq 26.4 \text{ OK 98 under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 0.411 \leq 26.4 \text{ OK 98 under} \)

**Design Member 12, wind on back, Major Shear**
- \( f_v \leq F_v, 0.0 \leq 16.0 \text{ OK 100 under} \)

**Load Case: wind on back**
- \( F_y = 40.0 \text{ ksi} \)

*On gross area*
- \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100 under} \)
- \( f_t \leq F_t, 0.0 \leq 44.0 \text{ OK 100 under} \)

**Design Member 12, climber, Compression**
- \( f_a \leq F_a, 0.007 \leq 21.857 \text{ OK 100 under} \)

**Design Member 12, climber, Bending + Tension**
- \( f_t/F_t + f_b/F_b + f_y/F_y = 0.0/44.0 + 0.221/26.4 + 9.338/30.0 = 0.32 \leq 1 \text{ OK 68 under} \)

**Design Member 12, climber, Bending + Compression**
- \( f_a/F_a = 0.007/21.857 = 0.0 \leq 0.15 \quad \phi \)
- \( \phi \alpha /\phi \alpha + \phi \beta /\phi \beta + \phi \phi /\phi \phi = 0.007/21.857 + 0.221/26.4 + 9.338/30.0 = 0.32 \leq 1 \text{ OK 68 under} \)

**Design Member 12, wind on back, Tension**
- On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100 under} \)
- On net area \( f_t \leq F_t, 0.0 \leq 44.0 \text{ OK 100 under} \)
On net area $f_t \leq F_t$, 0.0 $\leq$ 44.0 OK 100% under

**Design Member 12, wind on back, Compression**

$f_a \leq F_a$, 0.062 $\leq$ 21.857 OK 100% under

**Design Member 12, wind on back, Bending + Tension**

$f_a/F_t+f_{bx}/F_{bx}+f_{by}/F_{by}=0.0/44.0+0.411/26.4+8.437/30.0=0.297 \leq 1$ OK 70% under

**Design Member 12, wind on back, Bending + Compression**

$f_a/F_a=0.062/21.857=0.003 \leq 0.15 : \Phi_0$

$\phi_t/\Phi_0+\phi_{bx}/\Phi_{bx}+\phi_{by}/\Phi_{by}=0.062/21.857+0.411/26.4+8.437/30.0=0.3 \leq 1$ OK 70% under
Checking design member 13
Members: 13
Group: Custom1
Section: 1/4 x 2 link

Load Case: wind on front
\( F_y = 40.0 \text{ ksi} \)
On gross area \( F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \)
\( F_y = 0.4 \cdot F_y = 0.4 \cdot 40.0 = 16.0 \text{ ksi} \)
\( K_{l/r} = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 4.0/0.577, 1.0 \cdot 4.0/0.072) = 55.426 \)
\( F_a = (1 - KL/r)^2/(2 \cdot C_c^2) \cdot F_y/FS = (1 - 55.426^2/(2 \cdot 117.548^2)) \cdot 40.0/1.83 = 19.424 \text{ ksi} \)

Design Member 13, wind on front, Major Bending
Tensile Bending Stress:
\( f_b \leq F_b \), \( 0.0 \leq 26.4 \text{ OK 100\%} \) under
Compressive Bending Stress:
\( f_b \leq F_b \), \( 0.0 \leq 26.4 \text{ OK 100\%} \) under

Design Member 13, wind on front, Minor Bending
Tensile Bending Stress:
\( f_b \leq F_b \), \( 2.841 \leq 30.0 \text{ OK 91\%} \) under
Compressive Bending Stress:
\( f_b \leq F_b \), \( 2.841 \leq 30.0 \text{ OK 91\%} \) under

Design Member 13, wind on front, Minor Shear
\( f_v \leq F_v \), \( 0.017 \leq 16.0 \text{ OK 100\%} \) under

Design Member 13, wind on front, Tension
On gross area \( f_t \leq F_t \), \( 0.0 \leq 24.0 \text{ OK 100\%} \) under
On net area \( f_t \leq F_t \), \( 0.0 \leq 44.0 \text{ OK 100\%} \) under

Design Member 13, wind on front, Compression
\( f_a \leq F_a \), \( 0.121 \leq 19.424 \text{ OK 99\%} \) under

Design Member 13, wind on front, Bending + Tension
\( f_a/F_t + f_b/F_b + f_v/F_v = 0.0/44.0 + 0.0/26.4 + 2.841/30.0 = 0.095 \leq 1 \text{ OK 91\%} \) under

Design Member 13, wind on front, Bending + Compression
\( f_a/F_a = 0.121/19.424 = 0.006 \leq 0.15 \cdot \Phi \)
\( \Phi_a = \Phi_b = \Phi_v = 0.121/19.424 + 0.0/26.4 + 2.841/30.0 = 0.101 \leq 1 \text{ OK 90\%} \) under

Load Case: climber
\( F_y = 40.0 \text{ ksi} \)
On gross area \( F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \)
\( F_y = 0.4 \cdot F_y = 0.4 \cdot 40.0 = 16.0 \text{ ksi} \)
\( K_{l/r} = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 4.0/0.577, 1.0 \cdot 4.0/0.072) = 55.426 \)
Calc by: FJC

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\[ F_{a} = \left( 1 - \frac{(KL/r)^2}{(2 + Cc^2)} \right) \times F_{y} / FS = \left( 1 - \frac{55.426^2}{(2 + 117.548^2)} \right) \times 40.0 / 1.83 = 19.424 \text{ ksi} \]

**Major Axis:**

\[ F_{b} = 0.66 \times F_{y} = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Major Axis:**

\[ F_{b} = 0.75 \times F_{y} = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

**Design Member 13, climber, Major Bending**

Tensile Bending Stress:

\[ f_{b} \leq F_{b}, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]

Compressive Bending Stress:

\[ f_{b} \leq F_{b}, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]

**Design Member 13, climber, Major Shear**

\[ f_{s} \leq F_{s}, \quad 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 13, climber, Minor Bending**

Tensile Bending Stress:

\[ f_{b} \leq F_{b}, \quad 1.967 \leq 30.0 \text{ OK 93% under} \]

Compressive Bending Stress:

\[ f_{b} \leq F_{b}, \quad 1.967 \leq 30.0 \text{ OK 93% under} \]

**Design Member 13, climber, Minor Shear**

\[ f_{s} \leq F_{s}, \quad 0.009 \leq 16.0 \text{ OK 100% under} \]

**Design Member 13, climber, Tension**

On gross area \( f_{t} \leq F_{t}, \quad 0.086 \leq 24.0 \text{ OK 100% under} \)

On net area \( f_{t} \leq F_{u}, \quad 0.086 \leq 44.0 \text{ OK 100% under} \)

**Design Member 13, climber, Compression**

\[ f_{a} \leq F_{a}, \quad 0.0 \leq 19.424 \text{ OK 100% under} \]

**Load Case: wind on back**

\( F_{y} = 40.0 \text{ ksi} \)

On gross area \( F_{t} = 0.6 + F_{y} = 0.6 + 40.0 = 24.0 \text{ ksi} \)

On net area \( F_{t} = 0.5 + F_{u} = 0.5 + 88.0 = 44.0 \text{ ksi} \)

\[ KL/r = \max (K_{x} \times l/r_{x}, K_{y} \times l/r_{y}) = \max (1.0 \times 4.0 / 0.577, 1.0 \times 4.0 / 0.072) = 55.426 \]

\[ F_{a} = \left( 1 - \frac{(KL/r)^2}{(2 + Cc^2)} \right) \times F_{y} / FS = \left( 1 - \frac{55.426^2}{(2 + 117.548^2)} \right) \times 40.0 / 1.83 = 19.424 \text{ ksi} \]

**Major Axis:**

\[ F_{b} = 0.66 \times F_{y} = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Major Axis:**

\[ F_{b} = 0.75 \times F_{y} = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

**Design Member 13, wind on back, Major Bending**

Tensile Bending Stress:

\[ f_{b} \leq F_{b}, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]

Compressive Bending Stress:

\[ f_{b} \leq F_{b}, \quad 0.0 \leq 26.4 \text{ OK 100% under} \]

**Design Member 13, wind on back, Major Shear**

\[ f_{s} \leq F_{s}, \quad 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 13, wind on back, Minor Bending**

Tensile Bending Stress:

\[ f_{b} \leq F_{b}, \quad 2.841 \leq 30.0 \text{ OK 91% under} \]

Compressive Bending Stress:

\[ f_{b} \leq F_{b}, \quad 2.841 \leq 30.0 \text{ OK 91% under} \]

**Design Member 13, wind on back, Minor Shear**

\[ f_{s} \leq F_{s}, \quad 0.017 \leq 16.0 \text{ OK 100% under} \]

**Design Member 13, wind on back, Tension**

On gross area \( f_{t} \leq F_{t}, \quad 0.121 \leq 24.0 \text{ OK 99% under} \)
On net area $f_i \leq F_i$, $0.121 \leq 44.0$ OK 100% under

**Design Member 13, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 19.424$ OK 100% under

**Design Member 13, wind on back, Bending + Tension**

$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.121/24.0 + 0.0/26.4 + 2.841/30.0 = 0.1 \leq 1$ OK 90% under

**Design Member 13, wind on back, Bending + Compression**

$f_a/F_a = 0.0/19.424 = 0.0 \leq 0.15 \ : \ : \phi$

$\phi_{\alpha} + \phi_{\beta_{yz}}/\phi_{\beta_{yz}} + \phi_{\beta_{xy}}/\phi_{\beta_{xy}} = 0.0/19.424 + 0.0/26.4 + 2.841/30.0 = 0.095 \leq 1$ OK 91% under
Checking design member 14 (X Primary Beam)

Members: 14
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area

\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ksi} \]

On net area

\[ F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ksi} \]

\[ K_l/r = \max(K_x \cdot l/r, K_y \cdot l/r) = \max(1.0 \times 36.0/0.586, 1.0 \times 36.0/0.586) = 61.433 \]

\[ F_a = \frac{(1 - K_l/r)^2}{(2 \times C_{c2})} \times F_y / F_S = \frac{(1 - 61.433^2/(2 \times 119.63^2))}{1.842} = 18.849 \text{ksi} \]

Major Axis:

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ksi} \]

Minor Axis:

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ksi} \]

**Design Member 14, wind on front, Major Bending**

Tensile Bending Stress:

\[ f_t \leq F_b, \quad 3.412 \leq 26.4 \text{ OK 87% under} \]

Compressive Bending Stress:

\[ f_t \leq F_b, \quad 3.412 \leq 26.4 \text{ OK 87% under} \]

**Design Member 14, wind on front, Major Shear**

\[ f_v \leq F_v, \quad 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 14, wind on front, Minor Bending**

Tensile Bending Stress:

\[ f_t \leq F_t, \quad 0.799 \leq 26.4 \text{ OK 97% under} \]

Compressive Bending Stress:

\[ f_t \leq F_t, \quad 0.799 \leq 26.4 \text{ OK 97% under} \]

**Design Member 14, wind on front, Minor Shear**

\[ f_v \leq F_v, \quad 0.088 \leq 16.0 \text{ OK 99% under} \]

**Design Member 14, wind on front, Tension**

On gross area

\[ f_t \leq F_t, \quad 0.0 \leq 24.0 \text{ OK 100% under} \]

On net area

\[ f_t \leq F_t, \quad 0.0 \leq 44.0 \text{ OK 100% under} \]

**Design Member 14, wind on front, Compression**

\[ f_t \leq F_a, \quad 0.05 \leq 18.849 \text{ OK 100% under} \]

**Design Member 14, wind on front, Bending + Tension**

\[ f_y/(F_x+f_x/F_{bx}+f_y/F_{by})=0.0/44.0+3.412/26.4+0.799/26.4=0.159 \leq 1 \text{ OK 84% under} \]

**Design Member 14, wind on front, Bending + Compression**

\[ f_y/F_a=0.05/18.849=0.003 \leq 0.15 \cdot \psi \]

\[ \psi_{d1} = 0.05/18.849 + 3.412/26.4 + 0.799/26.4 = 0.162 \leq 1 \text{ OK 84% under} \]

**Load Case: climber**

\[ F_y = 40.0 \text{ ksi} \]

On gross area

\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ksi} \]

On net area

\[ F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ksi} \]

\[ K_l/r = \max(K_x \cdot l/r, K_y \cdot l/r) = \max(1.0 \times 36.0/0.586, 1.0 \times 36.0/0.586) = 61.433 \]
Calc by: FJC
AquaClimb
11/24/2009

Checked by:
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\[ F_a = \left(1 - \frac{(KL/r)^2}{(2+Cc^2)}\right) \cdot \frac{F_y}{FS} = \left(1 - \frac{16.1433^2}{(2+119.63^2)}\right) \cdot 40.0 \cdot 1.842 = 18.849 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Design Member 14, climber, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 1.019 \leq 26.4 \text{ OK 96\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 1.019 \leq 26.4 \text{ OK 96\% under} \]

**Design Member 14, climber, Major Shear**
\[ f_s \leq F_s, \ 0.0 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 14, climber, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.35 \leq 26.4 \text{ OK 100\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.35 \leq 26.4 \text{ OK 100\% under} \]

**Design Member 14, climber, Minor Shear**
\[ f_s \leq F_s, \ 0.0 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 14, climber, Tension**
\[ f_t \leq F_t, \ 0.017 \leq 24.0 \text{ OK 100\% under} \]
\[ f_t \leq F_t, \ 0.017 \leq 44.0 \text{ OK 100\% under} \]

**Design Member 14, climber, Compression**
\[ f_a \leq F_a, \ 0.0 \leq 18.849 \text{ OK 100\% under} \]

**Design Member 14, climber, Bending + Tension**
\[ \frac{f_t}{F_t} + \frac{f_b}{F_b} + \frac{f_x}{F_x} + \frac{f_y}{F_y} = 0.017/24.0 + 1.019/26.4 + 0.035/26.4 = 0.041 \leq 1 \text{ OK 96\% under} \]

**Design Member 14, climber, Bending + Compression**
\[ \frac{f_a}{F_a} = 0.0/18.849 = 0.0 \leq 0.15 \quad \Phi = 0 \]
\[ \Phi = 0.0/18.849 + 1.019/26.4 + 0.035/26.4 = 0.041 \leq 1 \text{ OK 96\% under} \]

**Load Case: wind on back**
\[ F_y = 40.0 \text{ ksi} \]
- On gross area \( F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \)
\[ F_v = 0.4 \cdot F_y = 0.4 \cdot 40.0 = 16.0 \text{ ksi} \]
\[ KL/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 36.0/0.586, 1.0 \cdot 36.0/0.586) = 61.433 \]
\[ F_a = \left(1 - \frac{(KL/r)^2}{(2+Cc^2)}\right) \cdot \frac{F_y}{FS} = \left(1 - \frac{16.1433^2}{(2+119.63^2)}\right) \cdot 40.0 \cdot 1.842 = 18.849 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Design Member 14, wind on back, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 3.412 \leq 26.4 \text{ OK 87\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 3.412 \leq 26.4 \text{ OK 87\% under} \]

**Design Member 14, wind on back, Major Shear**
\[ f_s \leq F_s, \ 0.0 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 14, wind on back, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.799 \leq 26.4 \text{ OK 97\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.799 \leq 26.4 \text{ OK 97\% under} \]

**Design Member 14, wind on back, Minor Shear**
\[ f_s \leq F_s, \ 0.088 \leq 16.0 \text{ OK 99\% under} \]

**Design Member 14, wind on back, Tension**
- On gross area \( f_t \leq F_t, \ 0.05 \leq 24.0 \text{ OK 100\% under} \)
On net area $f_t \leq F_t$, 0.05 $\leq$ 44.0 OK 100% under

**Design Member 14, wind on back, Compression**

$f_a \leq F_a$, 0.0 $\leq$ 18.849 OK 100% under

**Design Member 14, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.05/24.0 + 3.412/26.4 + 0.799/26.4 = 0.162 \leq 1$ OK 84% under

**Design Member 14, wind on back, Bending + Compression**

$f_a/F_a = 0.0/18.849 = 0.0 \leq 0.15 \therefore \Phi_0$

$\Phi_0/\Phi_\alpha + \Phi_\beta + \Phi_\psi /\Phi_\psi = 0.0/18.849 + 3.412/26.4 + 0.799/26.4 = 0.159 \leq 1$ OK 84% under
Checking design member 15

Members: 15
Group: Custom1
Section: 1/2" diameter bar

Load Case: wind on front

- $F_y = 40.0$ ksi
- On gross area $F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0$ ksi
- On net area $F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0$ ksi
- $F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0$ ksi

$K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 20.0/0.125, 1.0 \times 20.0/0.125) = 160.0$

$F_a = \frac{12 \times \pi^2 E}{(23 \times (K_l/r)^2)} = \frac{12 \times \pi^2 \times 29000.995}{(23 \times 160.0^2)} = 5.833$ ksi

**Major Axis:**
- $F_{b_1} = 0.66 \times F_y = 0.66 \times 40.0 = 26.4$ ksi
- $F_{b_2} = 0.75 \times F_y = 0.75 \times 40.0 = 30.0$ ksi

**Design Member 15, wind on front, Major Bending**
- Tensile Bending Stress: $f_b \leq F_{b_1}, 0.041 \leq 26.4$ OK 100% under
- Compressive Bending Stress: $f_b \leq F_{b_2}, 0.041 \leq 30.0$ OK 100% under

**Design Member 15, wind on front, Major Shear**
- $f_v \leq F_v, 0.0 \leq 16.0$ OK 100% under

**Design Member 15, wind on front, Minor Bending**
- Tensile Bending Stress: $f_b \leq F_{b_1}, 9.447 \leq 30.0$ OK 69% under
- Compressive Bending Stress: $f_b \leq F_{b_2}, 9.447 \leq 30.0$ OK 69% under

**Design Member 15, wind on front, Minor Shear**
- $f_v \leq F_v, 0.139 \leq 16.0$ OK 99% under

**Design Member 15, wind on front, Tension**
- On gross area $f_t \leq F_t, 0.0 \leq 24.0$ OK 100% under
- On net area $f_t \leq F_t, 0.0 \leq 44.0$ OK 100% under

**Design Member 15, wind on front, Compression**
- $f_a \leq F_a, 0.179 \leq 5.833$ OK 97% under

**Design Member 15, wind on front, Bending + Tension**
- $f_{a_t}/F_{a_t} = f_{b_1}/F_{b_1} + t_{b_2}/F_{b_2} = 0.0/44.0 + 0.041/26.4 + 9.447/30.0 = 0.316 \leq 1$ OK 68% under

**Design Member 15, wind on front, Bending + Compression**
- $f_{a_2}/F_{a_2} = 0.179/5.833 = 0.031 \leq 0.15 \therefore \phi$
- $\phi_\theta = \frac{\Phi_\alpha + \Phi_\beta_2 + \Phi_\beta_1 + \Phi_\beta_3 + \Phi_\beta_4 + \Phi_\beta_5}{5.833} = 0.179/5.833 + 0.041/26.4 + 9.447/30.0 = 0.347 \leq 1$ OK 65% under

Load Case: climber

- $F_y = 40.0$ ksi
- On gross area $F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0$ ksi
- On net area $F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0$ ksi
- $F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0$ ksi

$K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 20.0/0.125, 1.0 \times 20.0/0.125) = 160.0$
Load Case: wind on back

\( F_y = 40.0 \) ksi

On gross area: \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \) ksi

On net area: \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \) ksi

\( K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 20.0/0.125, 1.0 \times 20.0/0.125) = 160.0 \)

\( F_a = 12 \times \pi^2 E/(23 \times (KL/r)^2) = 12 \times \pi^2 \times 29000.995/(23 \times 160.0^2) = 5.833 \) ksi

**Major Axis:**
- \( F_y = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \) ksi
- \( F_y = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \) ksi

**Design Member 15, climber, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_b, 0.097 \leq 26.4 \) OK 100% under
- Compressive Bending Stress: \( f_b \leq F_b, 0.097 \leq 26.4 \) OK 100% under

**Design Member 15, climber, Major Shear**

- \( f_s \leq F_v, 0.0 \leq 16.0 \) OK 100% under

**Design Member 15, climber, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_b, 0.492 \leq 30.0 \) OK 98% under
- Compressive Bending Stress: \( f_b \leq F_b, 0.492 \leq 30.0 \) OK 98% under

**Design Member 15, climber, Minor Shear**

- \( f_s \leq F_v, 0.0 \leq 16.0 \) OK 100% under

**Design Member 15, climber, Tension**

- On gross area: \( f_t \leq F_t, 0.06 \leq 24.0 \) OK 100% under
- On net area: \( f_t \leq F_n, 0.06 \leq 44.0 \) OK 100% under

**Design Member 15, climber, Compression**

- \( f_s \leq F_s, 0.0 \leq 5.833 \) OK 100% under

**Design Member 15, climber, Bending + Tension**

\( f_y/F_t + f_x/F_x + f_b/F_b = 0.06/24.0 + 0.097/26.4 + 0.492/30.0 = 0.023 \leq 0.1 \) OK 99% under

**Design Member 15, climber, Bending + Compression**

\( f_y/F_a = 0.0/5.833 = 0.0 \leq 0.15 \text{ under } \phi \theta \)

\( \phi_a + \phi_b + \phi_c + \phi_d + \phi_e + \phi_f = 0.0/5.833 + 0.097/26.4 + 0.492/30.0 = 0.02 \leq 0.1 \) OK 98% under

**Load Case: wind on back**
On net area $f_t \leq F_t$, $0.179 \leq 44.0$ OK 100% under

**Design Member 15, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 5.833$ OK 100% under

**Design Member 15, wind on back, Bending + Tension**

$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.179/24.0 + 0.041/26.4 + 9.447/30.0 = 0.324 \leq 1$ OK 68% under

**Design Member 15, wind on back, Bending + Compression**

$f_a/F_a = 0.0/5.833 = 0.0 \leq 0.15$ \[ \Phi \]

$\Phi_{\alpha} + \Phi_{\beta_x} + \Phi_{\beta_y} + \Phi_{\gamma} = 0.0/5.833 + 0.041/26.4 + 9.447/30.0 = 0.316 \leq 1$ OK 68% under
Checking design member 16

Members: 16
Group: Custom1
Section: 1/2" diameter bar

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\[ F_y = 0.4 \times F_u = 0.4 \times 40.0 = 16.0 \text{ ksi} \]
\[ \frac{K}{r} = \max \left( \frac{K_x}{l/r_x}, \frac{K_y}{l/r_y} \right) = \max \left( 1.0 \times 28.0/0.125, 1.0 \times 28.0/0.125 \right) = 224.0 \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

Design Member 16, wind on front, Major Bending
- Tensile Bending Stress: \( f_b \leq F_b \), \( 0.002 \leq 26.4 \text{ OK 100\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b \), \( 0.002 \leq 26.4 \text{ OK 100\% under} \)

Design Member 16, wind on front, Major Shear
\[ f_v \leq F_v, 0.0 \leq 16.0 \text{ OK 100\% under} \]

Design Member 16, wind on front, Minor Bending
- Tensile Bending Stress: \( f_b \leq F_b \), \( 13.26 \leq 30.0 \text{ OK 56\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b \), \( 13.26 \leq 30.0 \text{ OK 56\% under} \)

Design Member 16, wind on front, Minor Shear
\[ f_v \leq F_v, 0.165 \leq 16.0 \text{ OK 99\% under} \]

Design Member 16, wind on front, Tension
- On gross area \( f_t \leq F_t \), \( 0.02 \leq 24.0 \text{ OK 100\% under} \)
- On net area \( f_t \leq F_t \), \( 0.02 \leq 44.0 \text{ OK 100\% under} \)

Design Member 16, wind on front, Compression
\[ f_a \leq F_a, 0.0 \leq 2.976 \text{ OK 100\% under} \]

Design Member 16, wind on front, Bending + Tension
\[ f_t/F_t + f_b/F_b + f_v/F_v = 0.02/24.0 + 0.002/26.4 + 13.26/30.0 = 0.443 \leq 1 \text{ OK 56\% under} \]

Design Member 16, wind on front, Bending + Compression
\[ f_t/F_a = 0.0/2.976 = 0.0 \leq 0.15 \text{ \&\&} \]
\[ \phi_{a} \Phi_{\alpha} + \phi_{\beta} \Phi_{\beta} + \phi_{v} \Phi_{v} = 0.0/2.976 + 0.002/26.4 + 13.26/30.0 = 0.442 \leq 1 \text{ OK 56\% under} \]

Load Case: climber
\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\[ F_y = 0.4 \times F_u = 0.4 \times 40.0 = 16.0 \text{ ksi} \]
\[ \frac{K}{r} = \max \left( \frac{K_x}{l/r_x}, \frac{K_y}{l/r_y} \right) = \max \left( 1.0 \times 28.0/0.125, 1.0 \times 28.0/0.125 \right) = 224.0 \]
Calc by: FJC AquaClimb

Checked by: GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

Calculation:

\[ F_a = \frac{12 \pi^2 E}{23 \times (KL/r)^2} = \frac{12 \pi^2 E}{23 \times 29000.995^2} = 2.976 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 F_y = 0.66 \times 40 = 26.4 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.75 F_y = 0.75 \times 40 = 30.0 \text{ ksi} \]

**Design Member 16, climber, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, 0.135 \leq 26.4 \text{ OK 99} \%

Compressive Bending Stress:

\[ f_b \leq F_b, 0.135 \leq 26.4 \text{ OK 99} \%

**Design Member 16, climber, Major Shear**

\[ f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100} \%

**Design Member 16, climber, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, 1.29 \leq 30.0 \text{ OK 96} \%

Compressive Bending Stress:

\[ f_b \leq F_b, 1.29 \leq 30.0 \text{ OK 96} \%

**Design Member 16, climber, Minor Shear**

\[ f_v \leq F_v, 0.0 \leq 16.0 \text{ OK 100} \%

**Design Member 16, climber, Compression**

\[ f_t \leq F_t, 0.029 \leq 2.976 \text{ OK 99} \%

**Design Member 16, climber, Bending + Tension**

\[ f_t/F_t + f_b/F_b + f_v/F_v = 0.029/2.976 + 0.135/26.4 + 0.048/30.0 = 0.048 \leq 1 \text{ OK 95} \%

**Design Member 16, climber, Bending + Compression**

\[ f_b/F_b = 0.029/2.976 = 0.01 \leq 0.15 \text{ under} \]

\[ \phi_f/\phi_{f_b} + \phi_{f_v}/\phi_{f_v} = 0.029/2.976 + 0.135/26.4 + 0.048/30.0 = 0.058 \leq 1 \text{ OK 94} \%

**Load Case: wind on back**

\[ F_y = 40.0 \text{ ksi} \]

On gross area:

\[ f_t \leq F_t, 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area:

\[ f_t \leq F_t, 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 28.0, 0.125 \times 28.0, 0.125) = 224.0 \]

\[ F_a = \frac{12 \pi^2 E}{23 \times (KL/r)^2} = \frac{12 \pi^2 E}{23 \times 224.0^2} = 2.976 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.75 F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

**Design Member 16, wind on back, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, 0.002 \leq 26.4 \text{ OK 100} \%

Compressive Bending Stress:

\[ f_b \leq F_b, 0.002 \leq 26.4 \text{ OK 100} \%

**Design Member 16, wind on back, Major Shear**

\[ f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100} \%

**Design Member 16, wind on back, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, 13.26 \leq 30.0 \text{ OK 56} \%

Compressive Bending Stress:

\[ f_b \leq F_b, 13.26 \leq 30.0 \text{ OK 56} \%

**Design Member 16, wind on back, Minor Shear**

\[ f_v \leq F_v, 0.165 \leq 16.0 \text{ OK 99} \%

**Design Member 16, wind on back, Tension**

On gross area:

\[ f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100} \% \]
On net area $f_t \leq F_t$, 0.0 $\leq$ 44.0 OK 100% under

**Design Member 16, wind on back, Compression**

$f_a \leq F_a$, 0.02 $\leq$ 2.976 OK 99% under

**Design Member 16, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 0.002/26.4 + 13.26/30.0 = 0.442 \leq 1$ OK 56% under

**Design Member 16, wind on back, Bending + Compression**

$f_a/F_a = 0.02/2.976 = 0.007 \leq 0.15 \therefore \phi$

$\phi_\alpha/\Phi_\alpha + \phi_\beta^\gamma/\Phi_\beta^\gamma + \phi_\gamma^\delta/\Phi_\gamma^\delta = 0.02/2.976 + 0.002/26.4 + 13.26/30.0 = 0.449 \leq 1$ OK 55% under
Checking design member 17 (X Primary Beam)

Members: 17
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\[ K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 36.0/0.586, 1.0 \times 36.0/0.586) = 61.433 \]

Design Member 17, wind on front, Major Bending
Tensile Bending Stress: \( f_b \leq F_b \)
Compressive Bending Stress: \( f_b \leq F_b \)

Design Member 17, wind on front, Major Shear
\( f_v \leq F_v \)

Design Member 17, wind on front, Minor Bending
Tensile Bending Stress: \( f_b \leq F_b \)
Compressive Bending Stress: \( f_b \leq F_b \)

Design Member 17, wind on front, Minor Shear
\( f_v \leq F_v \)

Design Member 17, wind on front, Tension
On gross area \( f_t \leq F_t \)
On net area \( f_t \leq F_t \)

Design Member 17, wind on front, Compression
\( f_a \leq F_a \)

Design Member 17, wind on front, Bending + Tension
\( f_y(F/y + F/bx + F/by)/F_y = 0.232/24.0 + 0.042/26.4 + 1.564/26.4 + 0.071 \leq 1 \text{ OK 93% under} \)

Design Member 17, wind on front, Bending + Compression
\( f_y/F_a = 0.0/18.849 = 0.0 \leq 0.15 \)

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\[ K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 36.0/0.586, 1.0 \times 36.0/0.586) = 61.433 \]
Calc by: FJC
AquaClimb
11/24/2009

Checked by: GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

\[
F_a = (1 - (KL/r)^2)(2 + Cc^2)) + F_y/FS = (1 - 61.433^2/(2 + 119.63^2)) + 40.0/1.842 = 18.849 \text{ ksi}
\]

**Major Axis:**
\[
F_b = 0.66*F_y = 0.66*40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**
\[
F_b = 0.66 + F_y = 0.66*40.0 = 26.4 \text{ ksi}
\]

**Design Member 17, climber, Major Bending**

- Tensile Bending Stress: 
  \[
f_b \leq F_b, \ 0.013 \leq 26.4 \text{ OK 100% under}
\]

- Compressive Bending Stress: 
  \[
f_b \leq F_b, \ 0.013 \leq 26.4 \text{ OK 100% under}
\]

**Design Member 17, climber, Major Shear**

- \(f_s \leq F_s, \ 0.0 \leq 16.0 \text{ OK 100% under}
\]

**Design Member 17, climber, Minor Bending**

- Tensile Bending Stress: 
  \[
f_b \leq F_b, \ 0.295 \leq 26.4 \text{ OK 99% under}
\]

- Compressive Bending Stress: 
  \[
f_b \leq F_b, \ 0.295 \leq 26.4 \text{ OK 99% under}
\]

**Design Member 17, climber, Minor Shear**

- \(f_s \leq F_s, \ 0.0 \leq 16.0 \text{ OK 100% under}
\]

**Design Member 17, climber, Compression**

- \(f_a \leq F_a, \ 0.029 \leq 18.849 \text{ OK 100% under}
\]

**Design Member 17, climber, Bending + Tension**

- \(f_b/F_b + f_b/F_b + f_b/F_b + f_b/F_b = 0.0/44.0 + 0.013/26.4 + 0.295/26.4 = 0.012 \leq 1 \text{ OK 99% under}
\]

**Design Member 17, climber, Bending + Compression**

- \(f_b/F_a = 0.029/18.849 = 0.002 \leq 0.15 \text{ under}
\]

- \(\phi_a/\phi_x + \phi_b/\phi_x + \phi_b/\phi_y = 0.029/18.849 + 0.013/26.4 + 0.295/26.4 = 0.013 \leq 1 \text{ OK 99% under}
\]

**Load Case: wind on back**

- \(F_y = 40.0 \text{ ksi}
\]

- On gross area \(f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100% under}
\]

- On net area \(f_t \leq F_n, \ 0.0 \leq 44.0 \text{ OK 100% under}
\]

- \(K_l/r = \max(K_x l/r, K_y l/r) = \max(1.0*36.0/0.586, 1.0*36.0/0.586) = 61.433
\]

- \(F_a = (1 - (KL/r)^2)(2 + Cc^2)) + F_y/FS = (1 - 61.433^2/(2 + 119.63^2)) + 40.0/1.842 = 18.849 \text{ ksi}
\]

**Major Axis:**
\[
F_b = 0.66*F_y = 0.66*40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**
\[
F_b = 0.66 + F_y = 0.66*40.0 = 26.4 \text{ ksi}
\]

**Design Member 17, wind on back, Major Bending**

- Tensile Bending Stress: 
  \[
f_b \leq F_b, \ 0.042 \leq 26.4 \text{ OK 100% under}
\]

- Compressive Bending Stress: 
  \[
f_b \leq F_b, \ 0.042 \leq 26.4 \text{ OK 100% under}
\]

**Design Member 17, wind on back, Major Shear**

- \(f_s \leq F_s, \ 0.0 \leq 16.0 \text{ OK 100% under}
\]

**Design Member 17, wind on back, Minor Bending**

- Tensile Bending Stress: 
  \[
f_b \leq F_b, \ 1.564 \leq 26.4 \text{ OK 94% under}
\]

- Compressive Bending Stress: 
  \[
f_b \leq F_b, \ 1.564 \leq 26.4 \text{ OK 94% under}
\]

**Design Member 17, wind on back, Minor Shear**

- \(f_s \leq F_s, \ 0.171 \leq 16.0 \text{ OK 99% under}
\]

**Design Member 17, wind on back, Tension**

- On gross area \(f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100% under}
\]
On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 17, wind on back, Compression**

$f_a \leq F_a$, $0.232 \leq 18.849$ OK 99% under

**Design Member 17, wind on back, Bending + Tension**

$f_a/F_t + f_bx/F_{bx} + f_by/F_{by} = 0.0/44.0 + 0.042/26.4 + 1.564/26.4 = 0.061 \leq 1$ OK 94% under

**Design Member 17, wind on back, Bending + Compression**

$f_a/F_a = 0.232/18.849 = 0.012 \leq 0.15 \therefore \psi_0$

$\phi_{\alpha}/\alpha + \phi_{\beta}/\beta + \phi_{\gamma}/\gamma = 0.232/18.849 + 0.042/26.4 + 1.564/26.4 = 0.073 \leq 1$ OK 93% under
Checking design member 18 (X Primary Beam)

Members: 18
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\[ K_l/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 36.0 / 0.586, 1.0 \times 36.0 / 0.586) = 61.433 \]

\[ F_a = (1 - \frac{KL}{r})^2 / (2 \times C_c^2) = (1 - 61.433^2 / (2 \times 119.63^2)) = 18.849 \text{ ksi} \]

Major Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Minor Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Design Member 18, wind on front, Major Bending
Tensile Bending Stress:
\[ f_b \leq F_b, \ 0.023 \leq 26.4 \text{ OK 100\% under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \ 0.023 \leq 26.4 \text{ OK 100\% under} \]

Design Member 18, wind on front, Major Shear
\[ f_v \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100\% under} \]

Design Member 18, wind on front, Minor Bending
Tensile Bending Stress:
\[ f_b \leq F_b, \ 1.089 \leq 26.4 \text{ OK 96\% under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \ 1.089 \leq 26.4 \text{ OK 96\% under} \]

Design Member 18, wind on front, Minor Shear
\[ f_v \leq F_v, \ 0.082 \leq 16.0 \text{ OK 99\% under} \]

Design Member 18, wind on front, Tension
On gross area \( f_t \leq F_t, \ 0.002 \leq 24.0 \text{ OK 100\% under} \)
On net area \( f_t \leq F_t, \ 0.002 \leq 44.0 \text{ OK 100\% under} \)

Design Member 18, wind on front, Compression
\[ f_a \leq F_a, \ 0.0 \leq 18.849 \text{ OK 100\% under} \]

Design Member 18, wind on front, Bending + Tension
\[ \frac{f_v}{F_t} + \frac{f_{tx}}{F_{tx}} + \frac{f_{ty}}{F_{ty}} = 0.002/24.0 + 0.023/26.4 + 1.089/26.4 = 0.042 \leq 1 \text{ OK 96\% under} \]

Design Member 18, wind on front, Bending + Compression
\[ \frac{f_a}{F_t} = 0.0/18.849 = 0.0 \leq 0.15 \Rightarrow 0 \]
\[ \phi_\alpha + \phi_\beta + \phi_\gamma = 0.0/18.849 + 0.023/26.4 + 1.089/26.4 = 0.042 \leq 1 \text{ OK 96\% under} \]

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)
\[ K_l/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 36.0 / 0.586, 1.0 \times 36.0 / 0.586) = 61.433 \]
Calc by:             FJC
[72x746]AquaClimb
[510x746]11/24/2009

Checked by:
–  S T R U C T U R A L  E N G I N E E R S

\[ F_a = \left(1 - \frac{KL}{r} \right)^2 \frac{2}{C_c} ) + \frac{F_y}{FS} = \left(1 - 61.433^2 \frac{2}{2(119.63)} \right)^2 + 40.0/1.842 = 18.849 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 18, climber, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.004 \leq 26.4 \text{ OK 100% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.004 \leq 26.4 \text{ OK 100% under} \]

**Design Member 18, climber, Major Shear**
\[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 18, climber, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.081 \leq 26.4 \text{ OK 100% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.081 \leq 26.4 \text{ OK 100% under} \]

**Design Member 18, climber, Minor Shear**

**Design Member 18, wind on back, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.023 \leq 26.4 \text{ OK 100% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.023 \leq 26.4 \text{ OK 100% under} \]

**Design Member 18, wind on back, Major Shear**
\[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 18, wind on back, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 1.089 \leq 26.4 \text{ OK 96% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 1.089 \leq 26.4 \text{ OK 96% under} \]

**Design Member 18, wind on back, Minor Shear**
\[ f_s \leq F_v, \ 0.082 \leq 16.0 \text{ OK 99% under} \]

**Design Member 18, wind on back, Tension**
- On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100% under} \)
- On net area \( f_t \leq F_n, \ 0.001 \leq 44.0 \text{ OK 100% under} \)

\[ F_y = 40.0 \text{ ksi} \]
- On gross area \( F_t = 0.6F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_v = 0.4F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]
- KL=r=\max(K_x r_x, K_y r_y) = \max(1.0 \times 36.0/0.586, 1.0 \times 36.0/0.586) = 61.433 \]

\[ F_a = \left(1 - \frac{KL}{r} \right)^2 \frac{2}{C_c} ) + \frac{F_y}{FS} = \left(1 - 61.433^2 \frac{2}{2(119.63)} \right)^2 + 40.0/1.842 = 18.849 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 18, wind on back, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.023 \leq 26.4 \text{ OK 100% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.023 \leq 26.4 \text{ OK 100% under} \]

**Design Member 18, wind on back, Major Shear**
\[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 18, wind on back, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 1.089 \leq 26.4 \text{ OK 96% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 1.089 \leq 26.4 \text{ OK 96% under} \]

**Design Member 18, wind on back, Minor Shear**
\[ f_s \leq F_v, \ 0.082 \leq 16.0 \text{ OK 99% under} \]

**Design Member 18, wind on back, Tension**
- On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100% under} \)
On net area $f_t \leq F_t$, 0.0 $\leq 44.0$ OK 100% under

**Design Member 18, wind on back, Compression**

$f_a \leq F_a$, 0.002 $\leq 18.849$ OK 100% under

**Design Member 18, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 0.023/26.4 + 1.089/26.4 = 0.042 \leq 1$ OK 96% under

**Design Member 18, wind on back, Bending + Compression**

$f_a/F_a = 0.002/18.849 = 0.0 \leq 0.15 \implies \phi = 0$

$\phi_a/\Phi_a + \phi_{bx}/\Phi_{bx} + \phi_{by}/\Phi_{by} = 0.002/18.849 + 0.023/26.4 + 1.089/26.4 = 0.042 \leq 1$ OK 96% under
Checking design member 19

Members: 19
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 16.279 / 0.586, 1.0 \times 16.279 / 0.586) = 27.78 \]

\[ F_c = (1 - (KL/r)^2 / (2 \times C^2)) \times F_y / F_S = (1 - 27.78^2 / (2 \times 119.63^2)) \times 40.0 / 1.752 = 22.213 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Design Member 19, wind on front, Major Bending

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 7.927 \leq 26.4 \text{ OK 70\% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 7.927 \leq 26.4 \text{ OK 70\% under} \]

Design Member 19, wind on front, Major Shear

\[ f_v \leq F_v, \quad 0.081 \leq 16.0 \text{ OK 99\% under} \]

Design Member 19, wind on front, Minor Bending

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 1.798 \leq 26.4 \text{ OK 93\% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 1.798 \leq 26.4 \text{ OK 93\% under} \]

Design Member 19, wind on front, Minor Shear

\[ f_v \leq F_v, \quad 0.162 \leq 16.0 \text{ OK 99\% under} \]

Design Member 19, wind on front, Tension

On gross area \( f_t \leq F_t, \quad 0.177 \leq 24.0 \text{ OK 99\% under} \)

On net area \( f_t \leq F_t, \quad 0.177 \leq 44.0 \text{ OK 100\% under} \)

Design Member 19, wind on front, Compression

\[ f_a \leq F_a, \quad 0.0 \leq 22.213 \text{ OK 100\% under} \]

Design Member 19, wind on front, Bending + Tension

\[ f_y / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.177 / 24.0 + 7.927 / 26.4 + 1.798 / 26.4 = 0.376 \leq 1 \text{ OK 62\% under} \]

Design Member 19, wind on front, Bending + Compression

\[ f_y / F_a = 0.0 / 22.213 = 0.0 \leq 0.15 \therefore \phi = 0 \]

\[ \phi_x + \phi_y + 0.0 + 0.0 + 0.15 + 0.368 \leq 0 \text{ OK 63\% under} \]

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 16.279 / 0.586, 1.0 \times 16.279 / 0.586) = 27.78 \]
\[ F_a = (1 - \frac{(KL/r)^2}{(2+Cc)^2}) \times F_y / FS = (1 - \frac{127.78^2}{(2+199.63)^2}) \times 40.0 / 1.752 = 22.213 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 19, climber, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 2.0 \leq 26.4 \text{ OK 92\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 2.0 \leq 26.4 \text{ OK 92\% under} \]

**Design Member 19, climber, Major Shear**
\[ f_s \leq F_s, \ 0.095 \leq 16.0 \text{ OK 99\% under} \]

**Design Member 19, climber, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.325 \leq 26.4 \text{ OK 99\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.325 \leq 26.4 \text{ OK 99\% under} \]

**Design Member 19, climber, Minor Shear**
\[ f_s \leq F_s, \ 0.035 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 19, climber, Tension**
- On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100\% under} \)
- On net area \( f_t \leq F_t, \ 0.0 \leq 44.0 \text{ OK 100\% under} \)

**Design Member 19, climber, Compression**
\[ f_a \leq F_a, \ 0.047 \leq 22.213 \text{ OK 100\% under} \]

**Design Member 19, climber, Bending + Tension**
\[ f_t/F_t + f_b/F_b + f_y/F_y = 0.047 / 22.213 + 0.047 / 22.213 + 0.035 / 16.0 = 0.088 \leq 1 \text{ OK 91\% under} \]

**Design Member 19, climber, Bending + Compression**
\[ f_a/F_a = 0.047 / 22.213 = 0.002 \leq 0.15 \phi_0 \]
\[ \phi_0 = \frac{\phi_a + \phi_b + \phi_s}{\phi_a + \phi_b + \phi_s} = 0.047 / 22.213 + 0.047 / 22.213 + 0.035 / 16.0 = 0.09 \leq 1 \text{ OK 91\% under} \]

**Load Case: wind on back**
\[ F_y = 40.0 \text{ ksi} \]
- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\[ K_l/n = \max(K_x l/n, K_y l/n) = \max(1.0 \times 16.279 / 0.586, 1.0 \times 16.279 / 0.586) = 27.78 \]
\[ F_a = (1 - \frac{(KL/r)^2}{(2+Cc)^2}) \times F_y / FS = (1 - \frac{127.78^2}{(2+199.63)^2}) \times 40.0 / 1.752 = 22.213 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 19, wind on back, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 7.927 \leq 26.4 \text{ OK 70\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 7.927 \leq 26.4 \text{ OK 70\% under} \]

**Design Member 19, wind on back, Major Shear**
\[ f_s \leq F_s, \ 0.081 \leq 16.0 \text{ OK 99\% under} \]

**Design Member 19, wind on back, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 1.798 \leq 26.4 \text{ OK 93\% under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 1.798 \leq 26.4 \text{ OK 93\% under} \]

**Design Member 19, wind on back, Minor Shear**
\[ f_s \leq F_s, \ 0.162 \leq 16.0 \text{ OK 99\% under} \]

**Design Member 19, wind on back, Tension**
- On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100\% under} \)
Calc by: FJC
AquaClimb
11/24/2009

Checked by:

On net area $f_1 \leq F_t$, 0.0 $\leq 44.0$ OK 100% under

**Design Member 19, wind on back, Compression**

$f_a \leq F_a$, 0.177 $\leq 22.213$ OK 99% under

**Design Member 19, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 7.927/26.4 + 1.798/26.4 = 0.368 \leq 1$ OK 63% under

**Design Member 19, wind on back, Bending + Compression**

$f_a/F_a = 0.177/22.213 = 0.008 \leq 0.15 \therefore \Phi_0$

\[
\Phi_\alpha + \Phi_{\beta_x} + \Phi_{\beta_y} + \Phi_{\beta_v} = 0.177/22.213 + 7.927/26.4 + 1.798/26.4 = 0.376 \leq 1 \text{ OK 62% under}
\]
Checking design member 20

Members: 20
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

**F_y = 40.0 ksi**

- On gross area: \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area: \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 60.042/0.586, 1.0 \times 60.042/0.586) = 102.46 \]

**Major Axis:**

\[ F_{b\max} = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_{b\max} = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 20, wind on front, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_{b\max} \rightarrow 13.996 \leq 26.4 \text{ OK 47% under} \)
- Compressive Bending Stress: \( f_b \leq F_{b\max} \rightarrow 13.996 \leq 26.4 \text{ OK 47% under} \)

**Design Member 20, wind on front, Major Shear**

\( f_v \leq F_v \rightarrow 0.299 \leq 16.0 \text{ OK 98% under} \)

**Design Member 20, wind on front, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_{b\max} \rightarrow 2.844 \leq 26.4 \text{ OK 89% under} \)
- Compressive Bending Stress: \( f_b \leq F_{b\max} \rightarrow 2.844 \leq 26.4 \text{ OK 89% under} \)

**Design Member 20, wind on front, Minor Shear**

\( f_v \leq F_v \rightarrow 0.083 \leq 16.0 \text{ OK 99% under} \)

**Design Member 20, wind on front, Tension**

- On gross area: \( f_t \leq F_t \rightarrow 0.0 \leq 24.0 \text{ OK 100% under} \)
- On net area: \( f_t \leq F_t \rightarrow 0.0 \leq 44.0 \text{ OK 100% under} \)

**Design Member 20, wind on front, Compression**

\( f_a \leq F_a \rightarrow 2.585 \leq 13.266 \text{ OK 81% under} \)

**Design Member 20, wind on front, Bending + Tension**

\[ f_y/F_y + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0+13.996/26.4+2.844/26.4=0.638 \leq 1 \text{ OK 36% under} \]

**Design Member 20, wind on front, Bending + Compression**

Axial Ratio: \( f_a/F_a = 2.585/13.266 = 0.195 \)

- Major Ratio: \( C_{max} f_{by}/(1-f_a/F_{ex})F_{bx} = 1.0 \times 13.996/((1-2.585/14.225) \times 26.4) = 0.648 \)
- Minor Ratio: \( C_{min} f_{by}/(1-f_a/F_{ey})F_{by} = 1.0 \times 2.844/((1-2.585/14.225) \times 26.4) = 0.132 \)

**Load Case: climber**

\( F_y = 40.0 \text{ ksi} \)

- On gross area: \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area: \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
Calc by: FJC

\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x l/r_x K_y l/r_y) = \max(1.0 + 60.042/0.586, 1.0 + 60.042/0.586) = 102.46 \]

\[ F_a = (1 - (KL/r)(2 + Cc^2)) \times F_y / FS = (1 - 102.46^2 / (2 + 119.63^2)) \times 40.0 / 1.909 = 13.266 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 + F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 + F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Design Member 20, climber, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 2.63 \leq 26.4 \text{ OK 90\% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 2.63 \leq 26.4 \text{ OK 90\% under} \]

**Design Member 20, climber, Major Shear**

\[ f_v \leq F_v, \quad 0.045 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 20, climber, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 0.406 \leq 26.4 \text{ OK 98\% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 0.406 \leq 26.4 \text{ OK 98\% under} \]

**Design Member 20, climber, Minor Shear**

\[ f_v \leq F_v, \quad 0.012 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 20, climber, Tension**

On gross area \( f_t \leq F_t, \quad 0.36 \leq 24.0 \text{ OK 99\% under} \)

On net area \( f_t \leq F_t, \quad 0.36 \leq 44.0 \text{ OK 99\% under} \)

**Design Member 20, climber, Compression**

\[ f_a \leq F_a, \quad 0.0 \leq 13.266 \text{ OK 100\% under} \]

**Design Member 20, climber, Bending + Tension**

\[ f_a / F_t + f_b / F_b + f_y / F_{by} = 0.36 / 24.0 + 2.63 / 26.4 + 0.406 / 26.4 \leq 0.13 \leq 1 \text{ OK 87\% under} \]

**Design Member 20, climber, Bending + Compression**

\[ f_a / F_a = 0.0 / 13.266 = 0.0 \leq 0.15 \]

\[ \phi_a / \phi_x + \phi_b / \phi_y + \phi_{by} / \phi_{by} = 0.0 / 13.266 + 2.63 / 26.4 + 0.406 / 26.4 \leq 0.115 \leq 1 \text{ OK 89\% under} \]

**Load Case: wind on back**

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_{tu} = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x l/r_x K_y l/r_y) = \max(1.0 + 60.042/0.586, 1.0 + 60.042/0.586) = 102.46 \]

\[ F_a = (1 - (KL/r)(2 + Cc^2)) \times F_y / FS = (1 - 102.46^2 / (2 + 119.63^2)) \times 40.0 / 1.909 = 13.266 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 + F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 + F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Design Member 20, wind on back, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 13.996 \leq 26.4 \text{ OK 47\% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 13.996 \leq 26.4 \text{ OK 47\% under} \]

**Design Member 20, wind on back, Major Shear**

\[ f_v \leq F_v, \quad 0.299 \leq 16.0 \text{ OK 98\% under} \]

**Design Member 20, wind on back, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 2.844 \leq 26.4 \text{ OK 89\% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 2.844 \leq 26.4 \text{ OK 89\% under} \]

**Design Member 20, wind on back, Minor Shear**
Calc by: FJC  
AquaClimb  
11/24/2009  

Checked by:

\[ f_v \leq F_{v} \leq 0.083 \leq 16.0 \text{ OK } 99\% \text{ under} \]

**Design Member 20, wind on back, Tension**

On gross area \( f_t \leq F_t \leq 2.585 \leq 24.0 \text{ OK } 89\% \text{ under} \)

On net area \( f_t \leq F_t \leq 2.585 \leq 44.0 \text{ OK } 94\% \text{ under} \)

**Design Member 20, wind on back, Compression**

\[ f_a \leq F_a \leq 0.0 \leq 13.266 \text{ OK } 100\% \text{ under} \]

**Design Member 20, wind on back, Bending + Tension**

\[ \frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} = 2.585/24.0 + 13.996/26.4 + 2.844/26.4 = 0.746 \leq 1 \text{ OK } 25\% \text{ under} \]

**Design Member 20, wind on back, Bending + Compression**

\[ \frac{f_a}{F_a} = 0.0/13.266 = 0.0 \leq 0.15 \therefore \phi = \frac{1}{1 + 0.0} \]

\[ \phi_a / \Phi_\alpha + \phi_{\beta_x} / \Phi_\beta_x + \phi_{\beta_y} / \Phi_\beta_y = 0.0/13.266 + 13.996/26.4 + 2.844/26.4 = 0.638 \leq 1 \text{ OK } 36\% \text{ under} \]
Checking design member 21

Members: 21
Group: Custom1
Section: 1/2" diameter bar

Load Case: wind on front

Load Case: climber
Calc by: FJC

AquaClimb

11/24/2009

Checked by: GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

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Design Member 21, climber, Major Bending
Tensile Bending Stress:
\[ f_b \leq F_b, \quad 0.202 \leq 26.4 \text{ OK 99\% under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \quad 0.202 \leq 26.4 \text{ OK 99\% under} \]

Design Member 21, climber, Major Shear
\[ f_s \leq F_s, \quad 0.0 \leq 16.0 \text{ OK 100\% under} \]

Design Member 21, climber, Minor Bending
Tensile Bending Stress:
\[ f_b \leq F_b, \quad 4.391 \leq 30.0 \text{ OK 85\% under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \quad 4.391 \leq 30.0 \text{ OK 85\% under} \]

Design Member 21, climber, Minor Shear
\[ f_s \leq F_s, \quad 0.056 \leq 16.0 \text{ OK 100\% under} \]

Design Member 21, climber, Tension
On gross area \( f_t \leq F_t, \quad 0.04 \leq 24.0 \text{ OK 100\% under} \)
On net area \( f_t \leq F_t, \quad 0.04 \leq 44.0 \text{ OK 100\% under} \)

Design Member 21, climber, Compression
\[ f_s \leq F_s, \quad 0.0 \leq 18.546 \text{ OK 100\% under} \]

Design Member 21, climber, Bending + Tension
\[ \frac{f_a}{F_a} + \frac{f_t}{F_t} + \frac{f_b}{F_b} + \frac{f_y}{F_y} = 0.04/24.0 + 0.0264 + 4.391/30.0 = 0.156 \leq 1 \text{ OK 84\% under} \]

Design Member 21, climber, Bending + Compression
\[ \frac{f_a}{F_a} = 0.0/18.546 = 0.0 \leq 0.15 \quad \phi = 0 \]

Load Case: wind on back
\[ F_y = 40.0 \text{ ksi} \]
On gross area \( f_t \leq F_t, \quad 0.06 + 0.6 = 24.0 \text{ OK 100\% under} \)
On net area \( f_t \leq F_t, \quad 0.05 + 0.88 = 44.0 \text{ ksi} \)
\[ K_l/r = \max(1.0 \times 8.0/0.125, 1.0 \times 8.0/0.125) = 64.0 \]
\[ F_a = (1 - (KL/r)^2/(2Cc^2)) \times F_y/(FS = (1 - 64.0^2/(2 \times 119.63^2)) \times 40.0/1.848 = 18.546 \text{ ksi} \]

Major Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Major Axis:
\[ F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

Design Member 21, wind on back, Major Bending
Tensile Bending Stress:
\[ f_b \leq F_b, \quad 0.218 \leq 26.4 \text{ OK 99\% under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \quad 0.218 \leq 26.4 \text{ OK 99\% under} \]

Design Member 21, wind on back, Major Shear
\[ f_s \leq F_s, \quad 0.0 \leq 16.0 \text{ OK 100\% under} \]

Design Member 21, wind on back, Minor Bending
Tensile Bending Stress:
\[ f_b \leq F_b, \quad 7.243 \leq 30.0 \text{ OK 76\% under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, \quad 7.243 \leq 30.0 \text{ OK 76\% under} \]

Design Member 21, wind on back, Minor Shear
\[ f_s \leq F_s, \quad 0.136 \leq 16.0 \text{ OK 99\% under} \]

Design Member 21, wind on back, Tension
On gross area \( f_t \leq F_t, \quad 0.133 \leq 24.0 \text{ OK 99\% under} \)
On net area $f_t \leq F_t$, 0.133 ≤ 44.0 OK 100% under

**Design Member 21, wind on back, Compression**

$f_a \leq F_a$, 0.0 ≤ 18.546 OK 100% under

**Design Member 21, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.133/24.0 + 0.218/26.4 + 7.243/30.0 = 0.255 \leq 1$ OK 74% under

**Design Member 21, wind on back, Bending + Compression**

$f_a/F_a = 0.0/18.546 = 0.0 \leq 0.15 : \phi_0$

$\phi_0/\Phi_{alpha} + \phi_{beta}/\Phi_{beta} + \phi_{gamma}/\Phi_{gamma} = 0.0/18.546 + 0.218/26.4 + 7.243/30.0 = 0.25 \leq 1$ OK 75% under
Checking design member 22

Members: 22
Group: Custom1
Section: 1/4 x 2 link

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)
\( K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 9.0 / 0.577, 0.65 \times 9.0 / 0.072) = 81.06 \)
\( F_a = (1 - KL/r)^2 / (2 \times Cc^2) \times F_y / FS = (1 - 81.06^2 / (2 \times 117.548^2)) \times 40.0 / 1.884 = 16.181 \text{ ksi} \)

Design Member 22, wind on front, Major Bending

Tensile Bending Stress:
\( f_b \leq F_b, 0.0 \leq 26.4 \text{ OK 100% under} \)
Compressive Bending Stress:
\( f_b \leq F_b, 0.0 \leq 26.4 \text{ OK 100% under} \)

Design Member 22, wind on front, Major Shear
\( f_v \leq F_v, 0.0 \leq 16.0 \text{ OK 100% under} \)

Design Member 22, wind on front, Minor Bending

Tensile Bending Stress:
\( f_b \leq F_b, 2.525 \leq 30.0 \text{ OK 92% under} \)
Compressive Bending Stress:
\( f_b \leq F_b, 2.525 \leq 30.0 \text{ OK 92% under} \)

Design Member 22, wind on front, Minor Shear
\( f_v \leq F_v, 0.018 \leq 16.0 \text{ OK 100% under} \)

Design Member 22, wind on front, Tension

On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100% under} \)
On net area \( f_t \leq F_t, 0.0 \leq 44.0 \text{ OK 100% under} \)

Design Member 22, wind on front, Compression
\( f_b \leq F_a, 0.108 \leq 16.181 \text{ OK 99% under} \)

Design Member 22, wind on front, Bending + Tension
\( f_v/F_y + f_b/F_b = 0.0 / 44.0 + 0.0 / 26.4 + 2.525 / 30.0 = 0.084 \leq 1 \text{ OK 92% under} \)

Design Member 22, wind on front, Bending + Compression
\( f_b/F_a = 0.108 / 16.181 = 0.007 \leq 0.15 : \phi_0 \equiv \phi \)
\( \phi_a = \phi_b = \phi_{b_t} = \phi_{b_v} = 0.108 / 16.181 + 0.0 / 26.4 + 2.525 / 30.0 = 0.091 \leq 1 \text{ OK 91% under} \)

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)
\( K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 9.0 / 0.577, 0.65 \times 9.0 / 0.072) = 81.06 \)
Calc by: FJC
AquaClimb 11/24/2009

Checked by: GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

\[ F_a = \left(1 - \frac{(KL/r)^2}{(2 + Cc^2)}\right) \cdot F_y / FS = \left(1 - 81.06^2 / (2 + 117.548^2)\right) \cdot 40.0 / 1.884 = 16.181 \text{ ksi} \]

**Major Axis:**
- \( F_a = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \)
- \( F_a = 0.75 \cdot F_y = 0.75 \cdot 40.0 = 30.0 \text{ ksi} \)

**Design Member 22, climber, Major Bending**

- **Tensile Bending Stress:**
  \( f_b \leq F_b, 0.0 \leq 26.4 \text{ OK 100% under} \)
- **Compressive Bending Stress:**
  \( f_b \leq F_b, 0.0 \leq 26.4 \text{ OK 100% under} \)

**Design Member 22, climber, Major Shear**

- \( f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100% under} \)

**Design Member 22, climber, Minor Bending**

- **Tensile Bending Stress:**
  \( f_b \leq F_b, 1.321 \leq 30.0 \text{ OK 96% under} \)
- **Compressive Bending Stress:**
  \( f_b \leq F_b, 1.321 \leq 30.0 \text{ OK 96% under} \)

**Design Member 22, climber, Minor Shear**

- \( f_s \leq F_s, 0.008 \leq 16.0 \text{ OK 100% under} \)

**Design Member 22, climber, Tension**

- On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100% under} \)
- On net area \( f_t \leq F_t, 0.0 \leq 44.0 \text{ OK 100% under} \)

**Design Member 22, climber, Compression**

- \( f_a \leq F_a, 0.022 \leq 16.181 \text{ OK 100% under} \)

**Load Case: wind on back**

\[ F_y = 40.0 \text{ ksi} \]

- On gross area \( F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \)

- \( K_l/r = \max(K_x \cdot l/r, K_y \cdot l/r) = \max(1.0 \cdot 9.0/0.577, 0.65 \cdot 9.0/0.072) = 81.06 \)

- \( F_a = \left(1 - \frac{(KL/r)^2}{(2 + Cc^2)}\right) \cdot F_y / FS = \left(1 - 81.06^2 / (2 + 117.548^2)\right) \cdot 40.0 / 1.884 = 16.181 \text{ ksi} \)

**Major Axis:**
- \( F_a = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \)
- \( F_a = 0.75 \cdot F_y = 0.75 \cdot 40.0 = 30.0 \text{ ksi} \)

**Design Member 22, wind on back, Major Bending**

- **Tensile Bending Stress:**
  \( f_b \leq F_b, 0.0 \leq 26.4 \text{ OK 100% under} \)
- **Compressive Bending Stress:**
  \( f_b \leq F_b, 0.0 \leq 26.4 \text{ OK 100% under} \)

**Design Member 22, wind on back, Major Shear**

- \( f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100% under} \)

**Design Member 22, wind on back, Minor Bending**

- **Tensile Bending Stress:**
  \( f_b \leq F_b, 2.525 \leq 30.0 \text{ OK 92% under} \)
- **Compressive Bending Stress:**
  \( f_b \leq F_b, 2.525 \leq 30.0 \text{ OK 92% under} \)

**Design Member 22, wind on back, Minor Shear**

- \( f_s \leq F_s, 0.018 \leq 16.0 \text{ OK 100% under} \)

**Design Member 22, wind on back, Tension**

- On gross area \( f_t \leq F_t, 0.108 \leq 24.0 \text{ OK 100% under} \)
On net area $f_t \leq F_t$, $0.108 \leq 44.0$ OK 100% under

**Design Member 22, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 16.181$ OK 100% under

**Design Member 22, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.108/24.0 + 0.0/26.4 + 2.525/30.0 = 0.089 \leq 1$ OK 91% under

**Design Member 22, wind on back, Bending + Compression**

$f_a/F_a = 0.0/16.181 = 0.0 \leq 0.15 \therefore \phi = 0$

$\phi_{\alpha} + \phi_{\beta} + \phi_{\gamma} = 0.0/16.181 + 0.0/26.4 + 2.525/30.0 = 0.084 \leq 1$ OK 92% under
Checking design member 23

Members: 23
Group: Custom1
Section: 1/2" diameter bar

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area

\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area

\[ F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ Kl/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \times 4.0/0.125, 1.0 \times 4.0/0.125) = 32.0 \]

\[ F_a = 0.062/24.0 + 0.411/26.4 + 8.437/30.0 = 0.299 \leq 1 \text{ OK 70} \]

\[ \phi = 0.0/21.857 = 0.0 \leq 0.15 \text{ \& } \phi = 0.0/21.857 + 0.411/26.4 + 8.437/30.0 = 0.297 \leq 1 \text{ OK 70} \]

Design Member 23, wind on front, Major Bending

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 0.411 \leq 26.4 \text{ OK 98% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 0.411 \leq 26.4 \text{ OK 98% under} \]

Design Member 23, wind on front, Major Shear

\[ f_v \leq F_v, \quad 0.0 \leq 16.0 \text{ OK 100% under} \]

Design Member 23, wind on front, Minor Bending

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 8.437 \leq 30.0 \text{ OK 72% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 8.437 \leq 30.0 \text{ OK 72% under} \]

Design Member 23, wind on front, Minor Shear

\[ f_v \leq F_v, \quad 0.144 \leq 16.0 \text{ OK 99% under} \]

Design Member 23, wind on front, Tension

On gross area

\[ f_t \leq F_t, \quad 0.062 \leq 24.0 \text{ OK 100% under} \]

On net area

\[ f_t \leq F_t, \quad 0.062 \leq 44.0 \text{ OK 100% under} \]

Design Member 23, wind on front, Compression

\[ f_a \leq F_a, \quad 0.0 \leq 21.857 \text{ OK 100% under} \]

Design Member 23, wind on front, Bending + Tension

\[ f_a/F_t + f_b/F_b + f_v/F_v = 0.062/24.0 + 0.411/26.4 + 8.437/30.0 = 0.299 \leq 1 \text{ OK 70% under} \]

Design Member 23, wind on front, Bending + Compression

\[ f_a/F_a = 0.0/21.857 = 0.0 \leq 0.15 \text{ \& } \phi = 0.0/21.857 + 0.411/26.4 + 8.437/30.0 = 0.297 \leq 1 \text{ OK 70% under} \]

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]

On gross area

\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area

\[ F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ Kl/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \times 4.0/0.125, 1.0 \times 4.0/0.125) = 32.0 \]
Calc by: FJC
AquaClimb

\[ F_a = (1 - \left(\frac{KL}{r}\right)^2/(2+2C_c^2)) \times F_y / FS = (1 - 32.0^2/(2+119.63^2)) \times 40.0 / 1.765 = 21.857 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

**Design Member 23, climber, Major Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, 0.221 \leq 26.4 \text{ OK 99 under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 0.221 \leq 26.4 \text{ OK 99 under} \]

**Design Member 23, climber, Major Shear**
\[ f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100 under} \]

**Design Member 23, climber, Minor Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, 9.338 \leq 30.0 \text{ OK 69 under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 9.338 \leq 30.0 \text{ OK 69 under} \]

**Design Member 23, climber, Minor Shear**
\[ f_s \leq F_s, 0.219 \leq 16.0 \text{ OK 99 under} \]

**Design Member 23, climber, Tension**

On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100 under} \)

On net area \( f_t \leq F_n, 0.0 \leq 44.0 \text{ OK 100 under} \)

**Design Member 23, climber, Compression**
\[ f_a \leq F_a, 0.007 \leq 21.857 \text{ OK 100 under} \]

**Load Case: wind on back**

\( F_y = 40.0 \text{ ksi} \)

\[ F_a = 0.6 + F_y = 0.6 + 40.0 = 24.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ Kl/r = \max(K_y l/r_y, K_x l/r_x) = \max(1.0 \times 4.0 / 0.125, 1.0 \times 4.0 / 0.125) = 32.0 \]

\[ F_a = (1 - (KL/r)^2/(2 + 2C_c^2)) \times F_y / FS = (1 - 32.0^2/(2 + 119.63^2)) \times 40.0 / 1.765 = 21.857 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.75 \times F_y = 0.75 \times 40.0 = 30.0 \text{ ksi} \]

**Design Member 23, wind on back, Major Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, 0.411 \leq 26.4 \text{ OK 98 under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 0.411 \leq 26.4 \text{ OK 98 under} \]

**Design Member 23, wind on back, Major Shear**
\[ f_s \leq F_s, 0.0 \leq 16.0 \text{ OK 100 under} \]

**Design Member 23, wind on back, Minor Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, 8.437 \leq 30.0 \text{ OK 72 under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 8.437 \leq 30.0 \text{ OK 72 under} \]

**Design Member 23, wind on back, Minor Shear**
\[ f_s \leq F_s, 0.144 \leq 16.0 \text{ OK 99 under} \]

**Design Member 23, wind on back, Tension**

On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100 under} \)
On net area \( f_t \leq F_t \), 0.0 \( \leq \) 44.0 OK 100% under

**Design Member 23, wind on back, Compression**

\[ f_a \leq F_a, \ 0.062 \leq 21.857 \] OK 100% under

**Design Member 23, wind on back, Bending + Tension**

\[ \frac{f_a}{F_t} + \frac{f_a}{F_t} + \frac{f_a}{F_t} \leq 0.0/44.0 + 0.411/26.4 + 8.437/30.0 = 0.297 \leq 1 \] OK 70% under

**Design Member 23, wind on back, Bending + Compression**

\[ \frac{f_a}{F_a} = 0.062/21.857 = 0.003 \leq 0.15 \] \( \therefore \) \( \psi_0 \)

\[ \phi_{\alpha}/\phi_{\alpha} + \phi_{\beta}/\phi_{\beta} + \phi_{\gamma}/\phi_{\gamma} = 0.062/21.857 + 0.411/26.4 + 8.437/30.0 = 0.3 \leq 1 \] OK 70% under
Checking design member 24

Members: 24  
Group: Custom1  
Section: 1/4 x 2 link

Load Case: wind on front

- \( F_y = 40.0 \) ksi
- On gross area \( F_t = 0.6 \cdot F_y = 0.6 \times 40.0 = 24.0 \) ksi
- On net area \( F_t = 0.5 \cdot F_u = 0.5 \times 88.0 = 44.0 \) ksi

\( F_y = 0.4 \cdot F_y = 0.4 \times 40.0 = 16.0 \) ksi

\( K_l/r = \max (K_x \cdot l/r, K_y \cdot l/r) = \max (1.0 \times 4.0 \cdot 0.577, 1.0 \times 4.0 / 0.072) = 55.426 \)

\( F_a = \frac{1}{(1 - (K_l/r)^2 / (2 \cdot C_c^2))} \cdot F_y / F_S = \frac{1}{1 - 55.426^2 / (2 \cdot 117.548^2)} \cdot 40.0 / 1.83 = 19.424 \) ksi

Major Axis:
- \( F_b = 0.66 \cdot F_y = 0.66 \times 40.0 = 26.4 \) ksi
- \( F_b = 0.75 \cdot F_y = 0.75 \times 40.0 = 30.0 \) ksi

Design Member 24, wind on front, Major Bending

- Tensile Bending Stress: \( f_b \leq F_b \), 0.0 \( \leq 26.4 \) OK 100% under
- Compressive Bending Stress: \( f_b \leq F_b \), 0.0 \( \leq 26.4 \) OK 100% under

Design Member 24, wind on front, Major Shear

- \( f_v \leq F_v \), 0.0 \( \leq 16.0 \) OK 100% under

Design Member 24, wind on front, Minor Bending

- Tensile Bending Stress: \( f_b \leq F_b \), 2.841 \( \leq 30.0 \) OK 91% under
- Compressive Bending Stress: \( f_b \leq F_b \), 2.841 \( \leq 30.0 \) OK 91% under

Design Member 24, wind on front, Minor Shear

- \( f_v \leq F_v \), 0.017 \( \leq 16.0 \) OK 100% under

Design Member 24, wind on front, Tension

- On gross area \( f_t \leq F_t \), 0.0 \( \leq 24.0 \) OK 100% under
- On net area \( f_t \leq F_t \), 0.0 \( \leq 44.0 \) OK 100% under

Design Member 24, wind on front, Compression

- \( f_a \leq F_a \), 0.121 \( \leq 19.424 \) OK 99% under

Design Member 24, wind on front, Bending + Tension

- \( f_t / F_t = 0.0.04 \leq 0.04 / 40.0 + 0.0 = 24.0 / 26.4 + 0.095 \leq 1 \) OK 91% under

Design Member 24, wind on front, Bending + Compression

- \( f_a / F_a = 0.0.121 / 19.424 = 0.006 \leq 0.15 \cdot \phi_0 \)
- \( f_a / F_a = 0.0.121 / 19.424 = 0.006 \leq 0.15 \cdot \phi_0 \)

Load Case: climber

- \( F_y = 40.0 \) ksi
- On gross area \( F_t = 0.6 \cdot F_y = 0.6 \times 40.0 = 24.0 \) ksi
- On net area \( F_t = 0.5 \cdot F_u = 0.5 \times 88.0 = 44.0 \) ksi
- \( F_y = 0.4 \cdot F_y = 0.4 \times 40.0 = 16.0 \) ksi

\( K_l/r = \max (K_x \cdot l/r, K_y \cdot l/r) = \max (1.0 \times 4.0 \cdot 0.577, 1.0 \times 4.0 / 0.072) = 55.426 \)
Calc by: FJC AquaClimb 11/24/2009

Checked by: GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

\[ F_a = (1 - (KL/r)^2/(2 \cdot Cc^2)) \cdot F_y / FS = (1 - 55.426^2/(2 \cdot 117.548^2)) \cdot 40.0 / 1.83 = 19.424 \text{ ksi} \]

\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

\[ F_b = 0.75 \cdot F_y = 0.75 \cdot 40.0 = 30.0 \text{ ksi} \]

**Design Member 24, climber, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_b \), 0.0 \( \leq \) 26.4 OK 100% under
- Compressive Bending Stress: \( f_b \leq F_b \), 0.0 \( \leq \) 26.4 OK 100% under

**Design Member 24, climber, Major Shear**

- \( f_s \leq F_s \), 0.0 \( \leq \) 16.0 OK 100% under

**Design Member 24, climber, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_b \), 1.967 \( \leq \) 30.0 OK 93% under
- Compressive Bending Stress: \( f_b \leq F_b \), 1.967 \( \leq \) 30.0 OK 93% under

**Design Member 24, climber, Minor Shear**

- \( f_s \leq F_s \), 0.009 \( \leq \) 16.0 OK 100% under

**Design Member 24, climber, Tension**

- On gross area \( f_t \leq F_t \), 0.086 \( \leq \) 24.0 OK 100% under
- On net area \( f_t \leq F_t \), 0.086 \( \leq \) 44.0 OK 100% under

**Design Member 24, climber, Compression**

- \( f_a \leq F_a \), 0.0 \( \leq \) 19.424 OK 100% under

**Load Case: wind on back**

\[ F_y = 40.0 \text{ ksi} \]

- On gross area \( F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \)

\[ KL/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 4.0 / 0.577, 1.0 \cdot 4.0 / 0.072) = 55.426 \]

\[ F_a = (1 - (KL/r)^2/(2 \cdot Cc^2)) \cdot F_y / FS = (1 - 55.426^2/(2 \cdot 117.548^2)) \cdot 40.0 / 1.83 = 19.424 \text{ ksi} \]

\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

\[ F_b = 0.75 \cdot F_y = 0.75 \cdot 40.0 = 30.0 \text{ ksi} \]

**Design Member 24, wind on back, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_b \), 0.0 \( \leq \) 26.4 OK 100% under
- Compressive Bending Stress: \( f_b \leq F_b \), 0.0 \( \leq \) 26.4 OK 100% under

**Design Member 24, wind on back, Major Shear**

- \( f_s \leq F_s \), 0.0 \( \leq \) 16.0 OK 100% under

**Design Member 24, wind on back, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_b \), 2.841 \( \leq \) 30.0 OK 91% under
- Compressive Bending Stress: \( f_b \leq F_b \), 2.841 \( \leq \) 30.0 OK 91% under

**Design Member 24, wind on back, Minor Shear**

- \( f_s \leq F_s \), 0.017 \( \leq \) 16.0 OK 100% under

**Design Member 24, wind on back, Tension**

- On gross area \( f_t \leq F_t \), 0.121 \( \leq \) 24.0 OK 99% under
On net area $f_t \leq F_t$, $0.121 \leq 44.0$ OK 100% under

**Design Member 24, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 19.424$ OK 100% under

**Design Member 24, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.121/24.0 + 0.0/26.4 + 2.841/30.0 = 0.1 \leq 1$ OK 90% under

**Design Member 24, wind on back, Bending + Compression**

$f_a/F_a = 0.0/19.424 = 0.0 \leq 0.15 \Rightarrow \phi$

$\phi_{a}/\Phi_a + \phi_{bx}/\Phi_{bx} + \phi_{by}/\Phi_{by} = 0.0/19.424 + 0.0/26.4 + 2.841/30.0 = 0.095 \leq 1$ OK 91% under
Checking design member 25

Members: 25
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area
\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area
\[ F_t = 0.5 \times F_y = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 28.5/0.586, 1.0 \times 28.5/0.586) = 48.635 \]

\[ F_a = (1 - (KL/r)^2)/(2 \times Cc^2) \times F_y/FS = (1 - 48.635^2)/(2 \times 119.63^2) \times 40.0/1.811 = 20.265 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

**Design Member 25, wind on front, Major Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \text{ 0.0} \leq 24.0 \text{ OK 100\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \text{ 0.0} \leq 24.0 \text{ OK 100\% under} \]

**Design Member 25, wind on front, Major Shear**

- \[ f_v \leq F_v, \text{ 0.0} \leq 16.0 \text{ OK 100\% under} \]

**Design Member 25, wind on front, Minor Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \text{ 0.0} \leq 24.0 \text{ OK 100\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \text{ 0.0} \leq 24.0 \text{ OK 100\% under} \]

**Design Member 25, wind on front, Minor Shear**

- \[ f_v \leq F_v, \text{ 0.0} \leq 16.0 \text{ OK 100\% under} \]

**Design Member 25, wind on front, Tension**

- On gross area
  \[ f_t \leq F_t, \text{ 0.0} \leq 24.0 \text{ OK 100\% under} \]

- On net area
  \[ f_t \leq F_t, \text{ 0.0} \leq 44.0 \text{ OK 100\% under} \]

**Design Member 25, wind on front, Compression**

- \[ f_a \leq F_a, \text{ 0.0} \leq 20.265 \text{ OK 100\% under} \]

**Design Member 25, wind on front, Bending + Tension**

- \[ f_v/F_t + F_bx + F_by/F_t = 0.0/44.0 + 0.0/24.0 + 0.0/24.0 = 0.0 \leq 1 \text{ OK 100\% under} \]

**Design Member 25, wind on front, Bending + Compression**

- \[ f_v/F_a = 0.0/20.265 = 0.0 \leq 0.15 \cdot \psi \]

\[ \psi_{\alpha} + \psi_{\beta_1} + \psi_{\beta_2} + \psi_{\beta_3} + \psi_{\beta_4} = 0.0/20.265 + 0.0/24.0 + 0.0/24.0 + 0.0 = 0.0 \leq 1 \text{ OK 100\% under} \]

**Load Case: climber**

\[ F_y = 40.0 \text{ ksi} \]

On gross area
\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area
\[ F_t = 0.5 \times F_y = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 28.5/0.586, 1.0 \times 28.5/0.586) = 48.635 \]
Calc by: FJC
AquaClimb
11/24/2009

Checked by:

Gary K. Munkelt & Associates – Structural Engineers
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\[ F_a = (1-(KL/r)^2/(2+Cc^2)) \cdot F_y/FS = (1-48.635^2/(2+119.63^2)) \cdot 40.0/1.811 = 20.265 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Design Member 25, climber, Major Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100\% under} \]

**Design Member 25, climber, Major Shear**

- \[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 25, climber, Minor Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100\% under} \]

**Design Member 25, climber, Minor Shear**

- \[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 25, climber, Compression**

- \[ f_s \leq F_a, \ 0.0 \leq 20.265 \text{ OK 100\% under} \]

**Design Member 25, climber, Bending + Tension**

\[
\phi_a/\phi_b + \phi_{b_x}/\phi_{b_x} + \phi_{b_y}/\phi_{b_y} = 0.0/20.265 + 0.0/26.4 + 0.0/26.4 = 0.0 \leq 1 \text{ OK 100\% under} \]

**Design Member 25, climber, Bending + Compression**

\[
\phi_a/\phi_a = 0.0/20.265 \leq 0.15 \therefore \phi \leq \phi_0 \]

\[
\phi_a/\phi_b + \phi_{b_x}/\phi_{b_x} + \phi_{b_y}/\phi_{b_y} = 0.0/20.265 + 0.0/26.4 + 0.0/26.4 = 0.0 \leq 1 \text{ OK 100\% under} \]

**Load Case: wind on back**

\[ F_y = 40.0 \text{ ksi} \]

- On gross area \[ F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \]

- On net area \[ F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \]

\[ KL/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 28.5/0.586, 1.0 \cdot 28.5/0.586) = 48.635 \]

\[ F_a = (1-(KL/r)^2/(2+Cc^2)) \cdot F_y/FS = (1-48.635^2/(2+119.63^2)) \cdot 40.0/1.811 = 20.265 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \]

**Design Member 25, wind on back, Major Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 24.0 \text{ OK 100\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 24.0 \text{ OK 100\% under} \]

**Design Member 25, wind on back, Major Shear**

- \[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 25, wind on back, Minor Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 24.0 \text{ OK 100\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 24.0 \text{ OK 100\% under} \]

**Design Member 25, wind on back, Minor Shear**

- \[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 25, wind on back, Tension**

- On gross area \[ f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100\% under} \]
On net area $f_t \leq F_t$, 0.0 $\leq$ 44.0 OK 100% under

**Design Member 25, wind on back, Compression**

$f_a \leq F_a$, 0.0 $\leq$ 20.265 OK 100% under

**Design Member 25, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 0.0/24.0 + 0.0/24.0 = 0.0 \leq 1$ OK 100% under

**Design Member 25, wind on back, Bending + Compression**

$f_a/F_a = 0.0/20.265 = 0.0 \leq 0.15 \therefore \Phi$

$\phi_\alpha/\Phi_\alpha + \phi_\beta/\Phi_\beta + \phi_\gamma/\Phi_\gamma = 0.0/20.265 + 0.0/24.0 + 0.0/24.0 = 0.0 \leq 1$ OK 100% under
Checking design member 26 (Column)

Members: 26
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

- \( F_y = 40.0 \) ksi
  - On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \) ksi
  - On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \) ksi
  
  \[
  F_y = 0.4 \times F_u = 0.4 \times 40.0 = 16.0 \text{ ksi}
  \]

- \( K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 51.42/0.586, 1.0 \times 51.42/0.586) = 87.747 \)

- \( F_a = (1 - (KL/r)^2/(2 \times C_c^2)) \times F_y / F_S = (1 - 87.747^2/(2 \times 119.63^2)) \times 40.0 / 1.892 = 15.451 \) ksi

  **Major Axis:**
  - \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \) ksi

  **Minor Axis:**
  - \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \) ksi

**Design Member 26, wind on front, Major Bending**

- Tensile Bending Stress:
  - \( f_b \leq F_b, 10.751 \leq 26.4 \text{ OK 59\% under} \)
- Compressive Bending Stress:
  - \( f_b \leq F_b, 10.751 \leq 26.4 \text{ OK 59\% under} \)

**Design Member 26, wind on front, Major Shear**

- \( f_v \leq F_v, 0.342 \leq 16.0 \text{ OK 98\% under} \)

**Design Member 26, wind on front, Minor Bending**

- Tensile Bending Stress:
  - \( f_b \leq F_b, 4.108 \leq 26.4 \text{ OK 84\% under} \)
- Compressive Bending Stress:
  - \( f_b \leq F_b, 4.108 \leq 26.4 \text{ OK 84\% under} \)

**Design Member 26, wind on front, Minor Shear**

- \( f_v \leq F_v, 0.093 \leq 16.0 \text{ OK 99\% under} \)

**Design Member 26, wind on front, Tension**

- On gross area \( f_t \leq F_t, 2.344 \leq 24.0 \text{ OK 90\% under} \)
- On net area \( f_t \leq F_t, 2.344 \leq 44.0 \text{ OK 95\% under} \)

**Design Member 26, wind on front, Compression**

- \( f_a \leq F_a, 0.0 \leq 15.451 \text{ OK 100\% under} \)

**Design Member 26, wind on front, Bending + Tension**

- \( f_a/F_a + f_b/F_b + f_v/F_v = 2.344/24.0 + 10.751/26.4 + 4.108/26.4 = 0.66 \leq 1 \text{ OK 34\% under} \)

**Design Member 26, wind on front, Bending + Compression**

- \( f_a/F_a = 0.0/15.451 = 0.0 \leq 0.15 : \phi_0 \)

- \( \phi_a \Phi_a + \phi_b \Phi_b + \phi_v \Phi_v = 0.0/15.451 + 10.751/26.4 + 4.108/26.4 = 0.563 \leq 1 \text{ OK 44\% under} \)

Load Case: climber

- \( F_y = 40.0 \) ksi
  - On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \) ksi
  - On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \) ksi
  
  \[
  F_y = 0.4 \times F_u = 0.4 \times 40.0 = 16.0 \text{ ksi}
  \]

- \( K_l/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 51.42/0.586, 1.0 \times 51.42/0.586) = 87.747 \)
Calc by: FJC  AquaClimb  11/24/2009

Checked by: GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

\[ F_a = (1 - (KL/r)^2(2 + Cc^2)) \cdot F_y / FS = (1 - 87.747^2 / (2 + 119.63^2)) \cdot 40.0 / 1.892 = 15.451 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

### Design Member 26, climber, Major Bending

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 2.451 \leq 26.4 \text{ OK 91\% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \ 2.451 \leq 26.4 \text{ OK 91\% under} \]

### Design Member 26, climber, Major Shear

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 0.042 \leq 16.0 \text{ OK 100\% under} \]

### Design Member 26, climber, Minor Bending

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 1.256 \leq 26.4 \text{ OK 95\% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \ 1.256 \leq 26.4 \text{ OK 95\% under} \]

### Design Member 26, climber, Minor Shear

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 0.03 \leq 16.0 \text{ OK 100\% under} \]

### Design Member 26, climber, Compression

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 0.671 \leq 15.451 \text{ OK 96\% under} \]

### Design Member 26, climber, Bending + Tension

\[ f_b/F_t + f_b/F_y + f_b/F_y = 0.0 / 44.0 + 2.451 / 26.4 + 1.256 / 26.4 = 0.14 \leq 1 \text{ OK 86\% under} \]

### Design Member 26, climber, Bending + Compression

\[ f_b/F_a = 0.671 / 15.451 = 0.043 \leq 0.15 : \psi_0 \]

\[ \phi_a + \phi_{\psi_0} + \phi_{\psi_0} = 0.671 / 15.451 + 2.451 / 26.4 + 1.256 / 26.4 = 0.184 \leq 1 \text{ OK 82\% under} \]

### Load Case: wind on back

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 10.751 \leq 26.4 \text{ OK 59\% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \ 10.751 \leq 26.4 \text{ OK 59\% under} \]

### Design Member 26, wind on back, Major Bending

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 10.751 \leq 26.4 \text{ OK 59\% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \ 10.751 \leq 26.4 \text{ OK 59\% under} \]

### Design Member 26, wind on back, Major Shear

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 0.342 \leq 16.0 \text{ OK 98\% under} \]

### Design Member 26, wind on back, Minor Bending

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 4.108 \leq 26.4 \text{ OK 84\% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \ 4.108 \leq 26.4 \text{ OK 84\% under} \]

### Design Member 26, wind on back, Minor Shear

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \ 0.093 \leq 16.0 \text{ OK 99\% under} \]

### Design Member 26, wind on back, Tension

- **On gross area:**
  \[ f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100\% under} \]

- **On net area:**
  \[ f_t \leq F_t, \ 0.0 \leq 44.0 \text{ OK 100\% under} \]

- **On net area:**
  \[ f_t \leq F_t, \ 0.0 \leq 44.0 \text{ OK 100\% under} \]
On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 26, wind on back, Compression**

$f_a \leq F_a$, 2.344 $\leq 15.451$ OK 85% under

**Design Member 26, wind on back, Bending + Tension**

$f_a/F_t+f_{bx}/F_{bx}+f_{by}/F_{by}=0.0/44.0+10.751/26.4+4.108/26.4=0.563 \leq 1$ OK 44% under

**Design Member 26, wind on back, Bending + Compression**

Axial Ratio=$f_a/F_a=2.344/15.451=0.152$

Major Ratio=$C_{mx} f_{bx}/(1-f_a/F'_{ex})F_{bx}=1.0*10.751/((1-2.344/19.395)*26.4)=0.463$

Minor Ratio=$C_{my} f_{by}/(1-f_a/F'_{ey})F_{by}=1.0*4.108/((1-2.344/19.395)*26.4)=0.177$

Axial Ratio+Major Ratio+Minor Ratio=0.152+0.463+0.177=0.792 $\leq 1$ OK 21% under

$f_a/(0.6+F_y)+f_{bx}/F_{bx}+f_{by}/F_{by}=2.344/(0.6+40.0)+10.751/26.4+4.108/26.4=0.66 >= 1$ OK 34% under
Checking design member 27 (Column)

Members: 27
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\[
KL/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 39.373/0.586, 1.0 \times 39.373/0.586) = 67.19
\]

\[
F_a = \left(1 - \frac{(KL/r)^2}{2 \times C_c^2}\right) \times \frac{F_y}{FS} = \left(1 - \frac{67.19^2}{119.63^2}\right) \times \frac{40.0}{1.855} = 18.161 \text{ ksi}
\]

Design Member 27, wind on front, Major Bending

Tensile Bending Stress:

\( f_b \leq F_b \), \( 1.399 \leq 26.4 \text{ OK 95\% under} \)

Compressive Bending Stress:

\( f_b \leq F_b \), \( 1.399 \leq 26.4 \text{ OK 95\% under} \)

Design Member 27, wind on front, Major Shear

\( f_v \leq F_v \), \( 0.095 \leq 16.0 \text{ OK 99\% under} \)

Design Member 27, wind on front, Minor Bending

Tensile Bending Stress:

\( f_b \leq F_b \), \( 1.406 \leq 26.4 \text{ OK 95\% under} \)

Compressive Bending Stress:

\( f_b \leq F_b \), \( 1.406 \leq 26.4 \text{ OK 95\% under} \)

Design Member 27, wind on front, Minor Shear

\( f_v \leq F_v \), \( 0.043 \leq 16.0 \text{ OK 100\% under} \)

Design Member 27, wind on front, Tension

On gross area \( f_t \leq F_t \), \( 2.365 \leq 24.0 \text{ OK 90\% under} \)

On net area \( f_t \leq F_t \), \( 2.365 \leq 44.0 \text{ OK 95\% under} \)

Design Member 27, wind on front, Compression

\( f_a \leq F_a \), \( 0.0 \leq 18.161 \text{ OK 100\% under} \)

Design Member 27, wind on front, Bending + Tension

\[
\frac{f_y}{F_t} + \frac{f_b}{F_b} = 2.365/24.0 + 1.399/26.4 + 1.406/26.4 = 0.205 \leq 1 \text{ OK 80\% under}
\]

Design Member 27, wind on front, Bending + Compression

\[
\frac{f_a}{F_a} = 0.0/18.161 = 0.0 \leq 0.15 \quad \therefore
\]

Load Case: climber

\( F_y = 40.0 \text{ ksi} \)

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\[
KL/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 39.373/0.586, 1.0 \times 39.373/0.586) = 67.19
\]
Calc by: FJC
AquaClimb
Checked by: GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

\[
F_a = (1 - \frac{(KL/r)^2}{(2+Cc^2)}) \times F_y / FS = (1 - 67.19^2/(2+119.63^2)) \times 40.0 / 1.855 = 18.161 \text{ ksi}
\]

**Major Axis:**
\[
F_b = 0.66 \times F_y = 6.6 \times 40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**
\[
F_b = 0.66 \times F_y = 6.6 \times 40.0 = 26.4 \text{ ksi}
\]

**Design Member 27, climber, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_b, \ \text{0.0} \leq 26.4 \ \text{OK 100}\% \text{ under} \)
- Compressive Bending Stress: \( f_b \leq F_b, \ \text{0.0} \leq 26.4 \ \text{OK 100}\% \text{ under} \)

**Design Member 27, climber, Major Shear**

- \( f_s \leq F_s, \text{0.0} \leq 16.0 \ \text{OK 100}\% \text{ under} \)

**Design Member 27, climber, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_b, \text{0.338} \leq 26.4 \ \text{OK 99}\% \text{ under} \)
- Compressive Bending Stress: \( f_b \leq F_b, \text{0.338} \leq 26.4 \ \text{OK 99}\% \text{ under} \)

**Design Member 27, climber, Minor Shear**

- \( f_v \leq F_v, \text{0.011} \leq 16.0 \ \text{OK 100}\% \text{ under} \)

**Design Member 27, climber, Compression**

- \( f_a \leq F_a, \text{0.68} \leq 18.161 \ \text{OK 96}\% \text{ under} \)

**Design Member 27, climber, Bending + Tension**

\[
f_a/F_a + f_b/F_b + f_y/F_y = 0.0/44.0 + 0.0/26.4 + 0.0/26.4 = 0.013 \leq 1 \ \text{OK 99}\% \text{ under}
\]

**Design Member 27, climber, Bending + Compression**

\[
\phi \alpha / \phi \beta / \phi \gamma / \phi \rho = 0.68/18.161 + 0.0/26.4 + 0.338/26.4 = 0.05 \leq 1 \ \text{OK 95}\% \text{ under}
\]

**Load Case: wind on back**

\( F_y = 40.0 \text{ ksi} \)

- On gross area \( f_t \leq F_t, \text{0.6} \leq 24.0 \ \text{OK 100}\% \text{ under} \)
- On net area \( f_t \leq F_t, \text{0.0} \leq 44.0 \ \text{OK 100}\% \text{ under} \)

**Design Member 27, wind on back, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_b, \text{1.399} \leq 26.4 \ \text{OK 95}\% \text{ under} \)
- Compressive Bending Stress: \( f_b \leq F_b, \text{1.399} \leq 26.4 \ \text{OK 95}\% \text{ under} \)

**Design Member 27, wind on back, Major Shear**

- \( f_s \leq F_s, \text{0.095} \leq 16.0 \ \text{OK 99}\% \text{ under} \)

**Design Member 27, wind on back, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_b, \text{1.406} \leq 26.4 \ \text{OK 95}\% \text{ under} \)
- Compressive Bending Stress: \( f_b \leq F_b, \text{1.406} \leq 26.4 \ \text{OK 95}\% \text{ under} \)

**Design Member 27, wind on back, Minor Shear**

- \( f_v \leq F_v, \text{0.043} \leq 16.0 \ \text{OK 100}\% \text{ under} \)

**Design Member 27, wind on back, Tension**

- On gross area \( f_t \leq F_t, \text{0.0} \leq 24.0 \ \text{OK 100}\% \text{ under} \)
On net area $f_t \leq F_t$, 0.0 $\leq$ 44.0 OK 100% under

**Design Member 27, wind on back, Compression**

\[ f_a \leq F_a, \ 2.365 \leq 18.161 \text{ OK 87\% under} \]

**Design Member 27, wind on back, Bending + Tension**

\[ f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 1.399/26.4 + 1.406/26.4 = 0.106 \leq 1 \text{ OK 89\% under} \]

**Design Member 27, wind on back, Bending + Compression**

\[ f_a/F_a = 2.365/18.161 = 0.13 \leq 0.15 \implies \phi \]

\[ \phi_a/\phi_a + \phi_{bx}/\phi_{bx} + \phi_{by}/\phi_{by} = 2.365/18.161 + 1.399/26.4 + 1.406/26.4 = 0.237 \leq 1 \text{ OK 76\% under} \]
Checking design member 28

Members: 28
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_n = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\[ KL/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 41.367/0.586, 1.0 \times 41.367/0.586) = 70.593 \]

Major Axis:

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Minor Axis:

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Design Member 28, wind on front, Major Bending

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 13.653 \leq 26.4 \text{ OK 48% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 13.653 \leq 26.4 \text{ OK 48% under} \]

Design Member 28, wind on front, Major Shear

\[ f_v \leq F_v, \quad 0.215 \leq 16.0 \text{ OK 99% under} \]

Design Member 28, wind on front, Minor Bending

Tensile Bending Stress:

\[ f_b \leq F_b, \quad 4.055 \leq 26.4 \text{ OK 85% under} \]

Compressive Bending Stress:

\[ f_b \leq F_b, \quad 4.055 \leq 26.4 \text{ OK 85% under} \]

Design Member 28, wind on front, Minor Shear

\[ f_v \leq F_v, \quad 0.087 \leq 16.0 \text{ OK 99% under} \]

Design Member 28, wind on front, Tension

On gross area \( f_t \leq F_t, \quad 0.0 \leq 24.0 \text{ OK 100% under} \)

On net area \( f_t \leq F_n, \quad 0.0 \leq 44.0 \text{ OK 100% under} \)

Design Member 28, wind on front, Compression

\[ f_a \leq F_a, \quad 2.52 \leq 17.74 \text{ OK 86% under} \]

Design Member 28, wind on front, Bending + Tension

\[ f_a/F_a, f_b/F_b, f_d/F_d = 0.0/44.0 + 13.653/26.4 + 4.055/26.4 = 0.671 \leq 1 \text{ OK 33% under} \]

Design Member 28, wind on front, Bending + Compression

\[ f_a/F_a = 2.52/17.74 = 0.142 \leq 0.15 = \varphi \]

\[ f_a, f_b, f_d, f_v = 2.52/17.74 + 13.653/26.4 + 4.055/26.4 = 0.813 \leq 1 \text{ OK 19% under} \]

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_n = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\[ KL/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 41.367/0.586, 1.0 \times 41.367/0.586) = 70.593 \]
\[ F_a = (1 - (KL/r)^2/(2 + Cc^2)) + F_y / FS = (1 - 70.593^2/(2 + 119.63^2)) + 40.0 / 1.862 = 17.74 \text{ ksi} \]

**Major Axis:**
\[ F_a = 0.66 + F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_a = 0.66 + F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Design Member 28, climber, Major Bending**

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \] 2.728 \leq 26.4 OK 90% under

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \] 2.728 \leq 26.4 OK 90% under

**Design Member 28, climber, Major Shear**

- \[ f_s \leq F_s, \] 0.115 \leq 16.0 OK 99% under

**Design Member 28, climber, Minor Bending**

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \] 0.598 \leq 26.4 OK 98% under

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \] 0.598 \leq 26.4 OK 98% under

**Design Member 28, climber, Minor Shear**

- \[ f_s \leq F_s, \] 0.02 \leq 16.0 OK 100% under

**Design Member 28, climber, Compression**

- \[ f_a \leq F_a, \] 0.0 \leq 17.74 OK 100% under

**Design Member 28, climber, Bending + Tension**

- \[ f_b/F_a + f_b = 0.372/24.0 + 2.728/26.4 + 0.598/26.4 = 0.141 \leq 1 \text{ OK 86% under} \]

**Design Member 28, climber, Bending + Compression**

- \[ F_a/F_b = 0.0/17.74 = 0.0 \leq 0.15 \text{ \ , \ } \phi_0 \]

- \[ \phi_\alpha + \phi_\beta + \phi_\gamma + \phi_\delta + \phi_\phi = 0.0 + 17.4 + 0.0 + 1.41 + 0.0 = 1 \leq 0.126 \text{ \leq 1 OK 87% under} \]

**Load Case: wind on back**

- \[ F_y = 40.0 \text{ ksi} \]

- On gross area \[ f_t \leq F_t, \] 0.6 + 40.0 = 24.0 OK 89% under

- On net area \[ f_t \leq F_n, \] 0.6 + 44.0 = 44.0 OK 99% under

**Design Member 28, wind on back, Major Bending**

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \] 13.653 \leq 26.4 OK 48% under

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \] 13.653 \leq 26.4 OK 48% under

**Design Member 28, wind on back, Major Shear**

- \[ f_s \leq F_s, \] 0.215 \leq 16.0 OK 99% under

**Design Member 28, wind on back, Minor Bending**

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \] 4.055 \leq 26.4 OK 85% under

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \] 4.055 \leq 26.4 OK 85% under

**Design Member 28, wind on back, Minor Shear**

- \[ f_s \leq F_s, \] 0.087 \leq 16.0 OK 99% under

**Design Member 28, wind on back, Tension**

- On gross area \[ f_t \leq F_t, \] 2.52 \leq 24.0 OK 89% under
On net area $f_t \leq F_t$, 2.52 ≤ 44.0 OK 94% under

**Design Member 28, wind on back, Compression**

$f_a \leq F_a$, 0.0 ≤ 17.74 OK 100% under

**Design Member 28, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 2.52/24.0 + 13.653/26.4 + 4.055/26.4 = 0.776 \leq 1$ OK 22% under

**Design Member 28, wind on back, Bending + Compression**

$f_a/F_a = 0.0/17.74 = 0.0 \leq 0.15 \Rightarrow \phi = 0$

$\phi_a/\phi_a + \phi_{by}/\phi_{by} = 0.0/17.74 + 13.653/26.4 + 4.055/26.4 = 0.671 \leq 1$ OK 33% under
Calc by:             FJC  
Checked by:  
Gary K. Munkelt & Associates – Structural Engineers  
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Checking design member 29 (Column)
Members: 29  
Group: Custom1  
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]

On gross area: \[ F_a = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area: \[ F_a = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ \frac{K_t}{r} = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 39.85/0.586, 1.0 \times 39.85/0.586) = 68.003 \]

**Major Axis:**

\[ F_{b_m} = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_{b_m} = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 29, wind on front, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_{b_m}, 3.509 \leq 26.4 \text{ OK 87\% under} \]

Compressive Bending Stress:

\[ f_b \leq F_{b_m}, 3.509 \leq 26.4 \text{ OK 87\% under} \]

**Design Member 29, wind on front, Major Shear**

\[ f_v \leq F_v, 0.176 \leq 16.0 \text{ OK 99\% under} \]

**Design Member 29, wind on front, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_{b_m}, 0.47 \leq 26.4 \text{ OK 98\% under} \]

Compressive Bending Stress:

\[ f_b \leq F_{b_m}, 0.47 \leq 26.4 \text{ OK 98\% under} \]

**Design Member 29, wind on front, Minor Shear**

\[ f_v \leq F_v, 0.021 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 29, wind on front, Tension**

On gross area: \[ f_t \leq F_t, 2.375 \leq 24.0 \text{ OK 90\% under} \]

On net area: \[ f_t \leq F_t, 2.375 \leq 44.0 \text{ OK 95\% under} \]

**Design Member 29, wind on front, Compression**

\[ f_a \leq F_a, 0.0 \leq 18.061 \text{ OK 100\% under} \]

**Design Member 29, wind on front, Bending + Tension**

\[ f_y/F_a + f_{dx}/F_{bx} + f_{dy}/F_{by} = 2.375/24.0 + 3.509/26.4 + 0.47/26.4 = 0.25 \leq 1 \text{ OK 75\% under} \]

**Design Member 29, wind on front, Bending + Compression**

\[ f_y/F_a = 0.0/18.061 = 0.0 \leq 0.15 \text{ OK 85\% under} \]

**Load Case: climber**

\[ F_y = 40.0 \text{ ksi} \]

On gross area: \[ F_y = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area: \[ F_y = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ \frac{K_t}{r} = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 39.85/0.586, 1.0 \times 39.85/0.586) = 68.003 \]
Calc by: FJC  
AquaClimb  
11/24/2009

Checked by:

Gary K. Munkelt & Associates – Structural Engineers

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\[
F_a = (1-(KL/r)^2/(2+Cc^2)) + F_y/FS = (1-68.003^2/(2+119.63^2)) \times 40.0/1.857 = 18.061 \text{ ksi}
\]

**Major Axis:**
\[
F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**
\[
F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi}
\]

**Design Member 29, climber, Major Bending**

Tensile Bending Stress:
\[
f_b \leq F_b \leq 0.525 \leq 26.4 \text{ OK 98% under}
\]

Compressive Bending Stress:
\[
f_b \leq -F_b \leq 0.525 \leq 26.4 \text{ OK 98% under}
\]

**Design Member 29, climber, Major Shear**

\[
f_s \leq F_{sv} = 0.012 \leq 16.0 \text{ OK 100% under}
\]

**Design Member 29, climber, Minor Bending**

Tensile Bending Stress:
\[
f_b \leq F_b \leq 0.131 \leq 26.4 \text{ OK 100% under}
\]

Compressive Bending Stress:
\[
f_b \leq -F_b \leq 0.131 \leq 26.4 \text{ OK 100% under}
\]

**Design Member 29, climber, Minor Shear**

\[
f_s \leq F_{sv} = 0.004 \leq 16.0 \text{ OK 100% under}
\]

**Design Member 29, climber, Tension**

On gross area
\[
f_t \leq F_t = 0.0 \leq 24.0 \text{ OK 100% under}
\]

On net area
\[
f_t \leq F_n = 0.0 \leq 44.0 \text{ OK 100% under}
\]

**Design Member 29, climber, Compression**

\[
f_a \leq F_a = 0.325 \leq 18.061 \text{ OK 98% under}
\]

**Design Member 29, climber, Bending + Tension**

\[
f_{ft}/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 0.525/26.4 + 0.131/26.4 = 0.025 \leq 1 \text{ OK 98% under}
\]

**Design Member 29, climber, Bending + Compression**

\[
f_{fa}/F_a = 0.325/18.061 = 0.018 \leq 0.15 \phi_0
\]

\[
\phi_\alpha + \phi_\beta + \phi_\gamma + \phi_\psi = 0.325/18.061 + 0.525/26.4 + 0.131/26.4 = 0.043 \leq 1 \text{ OK 96% under}
\]

**Load Case: wind on back**

\[
F_y = 40.0 \text{ ksi}
\]

On gross area
\[
F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi}
\]

On net area
\[
F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi}
\]

\[
KL/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 39.85/0.586, 1.0 \times 39.85/0.586) = 68.003
\]

\[
F_a = (1-(KL/r)^2/(2+Cc^2)) + F_y/FS = (1-68.003^2/(2+119.63^2)) \times 40.0/1.857 = 18.061 \text{ ksi}
\]

**Major Axis:**
\[
F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**
\[
F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi}
\]

**Design Member 29, wind on back, Major Bending**

Tensile Bending Stress:
\[
f_b \leq F_b \leq 3.509 \leq 26.4 \text{ OK 87% under}
\]

Compressive Bending Stress:
\[
f_b \leq -F_b \leq 3.509 \leq 26.4 \text{ OK 87% under}
\]

**Design Member 29, wind on back, Major Shear**

\[
f_s \leq F_{sv} = 0.176 \leq 16.0 \text{ OK 99% under}
\]

**Design Member 29, wind on back, Minor Bending**

Tensile Bending Stress:
\[
f_b \leq F_{b} \leq 0.47 \leq 26.4 \text{ OK 98% under}
\]

Compressive Bending Stress:
\[
f_{b} \leq -F_b \leq 0.47 \leq 26.4 \text{ OK 98% under}
\]

**Design Member 29, wind on back, Minor Shear**

\[
f_s \leq F_{sv} = 0.021 \leq 16.0 \text{ OK 100% under}
\]

**Design Member 29, wind on back, Tension**

On gross area
\[
f_t \leq F_t = 0.0 \leq 24.0 \text{ OK 100% under}
\]
On net area $f_t \leq F_t$, 0.0 $\leq$ 44.0 OK 100% under

**Design Member 29, wind on back, Compression**

$f_a \leq F_a$, 2.375 $\leq$ 18.061 OK 87% under

**Design Member 29, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 3.509/26.4 + 0.47/26.4 = 0.151 \leq 1$ OK 85% under

**Design Member 29, wind on back, Bending + Compression**

$f_a/F_a = 2.375/18.061 = 0.132 \leq 0.15 \Rightarrow \phi 0$

$$\phi_{a}/\Phi_{a} + \phi_{bx}/\Phi_{bx} + \phi_{by}/\Phi_{by} = 2.375/18.061 + 3.509/26.4 + 0.47/26.4 = 0.282 \leq 1$$ OK 72% under
Checking design member 30

Members: 30
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

- **Tensile Bending Stress:**
  - $f_b \leq F_b$, 3.645 \leq 26.4 OK 86% under
- **Compressive Bending Stress:**
  - $f_b \leq F_b$, 3.645 \leq 26.4 OK 86% under

Design Member 30, wind on front, Major Shear

- **Tensile Bending Stress:**
  - $f_b \leq F_b$, 0.072 \leq 16.0 OK 100% under
- **Compressive Bending Stress:**
  - $f_b \leq F_b$, 0.072 \leq 16.0 OK 100% under

Design Member 30, wind on front, Tension

- **On gross area:** $f_t \leq F_t$, 0.0 \leq 24.0 OK 100% under
- **On net area:** $f_t \leq F_t$, 0.0 \leq 44.0 OK 100% under

Design Member 30, wind on front, Compression

- **On gross area:** $f_a \leq F_a$, 2.456 \leq 17.727 OK 86% under

Design Member 30, wind on front, Bending + Tension

- $f_t/F_t+F_b/F_b+F_v/F_v=0.0/44.0+3.645/26.4+0.159/26.4=0.144 \leq 1 OK 86% under

Design Member 30, wind on front, Bending + Compression

- $F_a/F_a=2.456/17.727=0.139 \leq 0.15 \phi_0$
- $\phi_\alpha+\phi_\beta+\phi_\gamma+\phi_v=2.456/17.727+3.645/26.4+0.159/26.4=0.283 \leq 1 OK 72% under$

Load Case: climber

- **Tensile Bending Stress:**
  - $F_y=40.0$ ksi
- **Compressive Bending Stress:**
  - $F_y=40.0$ ksi
- **Major Axis:**
  - $F_y=0.6\times F_y=0.6\times 40.0=24.0$ ksi
- **Minor Axis:**
  - $F_y=0.5\times F_y=0.5\times 88.0=44.0$ ksi
- **Kl/r = max(K_x \times l/r, K_y \times l/r) = max(1.0 \times 41.425/0.586, 1.0 \times 41.425/0.586)=70.69$
Calc by: FJC
AquaClimb
11/24/2009

Checked by: Gary K. Munkelt & Associates – Structural Engineers

\[ F_a = (1-(KL/r)^2/(2+Cc^2))+F_y/FS = (1-70.69^2/(2+119.63^2)) + 40.0/1.862 = 17.727 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

### Design Member 30, climber, Major Bending

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \quad 2.725 \leq 26.4 \text{ OK 90% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \quad 2.725 \leq 26.4 \text{ OK 90% under} \]

### Design Member 30, climber, Major Shear

- **Tensile Bending Stress:**
  \[ f_u \leq F_u, \quad 0.07 \leq 16.0 \text{ OK 100% under} \]

- **Compressive Bending Stress:**
  \[ f_u \leq F_u, \quad 0.07 \leq 16.0 \text{ OK 100% under} \]

### Design Member 30, climber, Minor Bending

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \quad 0.399 \leq 26.4 \text{ OK 98% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \quad 0.399 \leq 26.4 \text{ OK 98% under} \]

### Design Member 30, climber, Minor Shear

- **Tensile Bending Stress:**
  \[ f_u \leq F_u, \quad 0.007 \leq 16.0 \text{ OK 100% under} \]

- **Compressive Bending Stress:**
  \[ f_u \leq F_u, \quad 0.007 \leq 16.0 \text{ OK 100% under} \]

### Design Member 30, climber, Compression

- **Tensile Bending Stress:**
  \[ f_u \leq F_u, \quad 0.0 \leq 17.727 \text{ OK 100% under} \]

### Design Member 30, climber, Bending + Tension

\[ \frac{f_b}{F_b} + \frac{f_x}{F_x} + \frac{f_y}{F_y} = 0.325/24.0 + 2.725/26.4 + 0.399/26.4 = 0.132 \leq 1 \text{ OK 87% under} \]

### Design Member 30, climber, Bending + Compression

\[ \frac{F_a}{F_a} = 0.0/17.727 = 0.0 \leq 0.15 \Rightarrow \phi \]
\[ \phi = \frac{\phi_\alpha + \phi_x + \phi_y}{\phi_\alpha + \phi_x + \phi_y} = 0.0/17.727 + 2.725/26.4 + 0.399/26.4 = 0.118 \leq 1 \text{ OK 88% under} \]

### Load Case: Wind on back

\[ F_y = 40.0 \text{ ksi} \]

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \quad 2.456 \leq 24.0 \text{ OK 90% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \quad 2.456 \leq 24.0 \text{ OK 90% under} \]

### Design Member 30, wind on back, Major Bending

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \quad 3.645 \leq 26.4 \text{ OK 86% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \quad 3.645 \leq 26.4 \text{ OK 86% under} \]

### Design Member 30, wind on back, Major Shear

- **Tensile Bending Stress:**
  \[ f_u \leq F_u, \quad 0.072 \leq 16.0 \text{ OK 100% under} \]

- **Compressive Bending Stress:**
  \[ f_u \leq F_u, \quad 0.072 \leq 16.0 \text{ OK 100% under} \]

### Design Member 30, wind on back, Minor Bending

- **Tensile Bending Stress:**
  \[ f_b \leq F_b, \quad 0.159 \leq 26.4 \text{ OK 99% under} \]

- **Compressive Bending Stress:**
  \[ f_b \leq F_b, \quad 0.159 \leq 26.4 \text{ OK 99% under} \]

### Design Member 30, wind on back, Minor Shear

- **Tensile Bending Stress:**
  \[ f_u \leq F_u, \quad 0.0 \leq 16.0 \text{ OK 100% under} \]

### Design Member 30, wind on back, Tension

- **On gross area:**
  \[ f_t \leq F_t, \quad 2.456 \leq 24.0 \text{ OK 90% under} \]
On net area $f_t \leq F_t$, $2.456 \leq 44.0$ OK 94% under

**Design Member 30, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 17.727$ OK 100% under

**Design Member 30, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 2.456/24.0 + 3.645/26.4 + 0.159/26.4 = 0.246 \leq 1$ OK 75% under

**Design Member 30, wind on back, Bending + Compression**

$f_a/F_a = 0.0/17.727 = 0.0 \leq 0.15 \therefore \phi$

$\phi_{a}/\phi_{a} + \phi_{xz}/\phi_{xz} + \phi_{wy}/\phi_{wy} = 0.0/17.727 + 3.645/26.4 + 0.159/26.4 = 0.144 \leq 1$ OK 86% under
Checking design member 31 (Column)

Members: 31
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

F_y = 40.0 ksi
On gross area F_t = 0.6 * F_y = 0.6 * 40.0 = 24.0 ksi
On net area F_t = 0.5 * F_u = 0.5 * 88.0 = 44.0 ksi
F_y = 0.4 + F_y = 0.4 + 40.0 = 16.0 ksi
K_l/r = max(K_x/l/r_x, K_y/l/r_y) = max(1.0 * 26.5/0.586, 1.0 * 26.5/0.586) = 45.222
F_a = (1 - (K_l/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 45.222^2 / (2 * 119.63^2)) * 40.0 / 1.802 = 20.615 ksi

Major Axis:
F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 ksi

Minor Axis:
F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 ksi

Design Member 31, wind on front, Major Bending

Tensile Bending Stress:
f_b ≤ F_b, 0.111 ≤ 26.4 OK 100% under
Compressive Bending Stress:
f_b ≤ F_b, 0.111 ≤ 26.4 OK 100% under

Design Member 31, wind on front, Major Shear

f_v ≤ F_v, 0.004 ≤ 16.0 OK 100% under

Design Member 31, wind on front, Minor Bending

Tensile Bending Stress:
f_b ≤ F_b, 3.875 ≤ 26.4 OK 85% under
Compressive Bending Stress:
f_b ≤ F_b, 3.875 ≤ 26.4 OK 85% under

Design Member 31, wind on front, Minor Shear

f_v ≤ F_v, 0.178 ≤ 16.0 OK 99% under

Design Member 31, wind on front, Tension

On gross area f_t ≤ F_t, 0.0 ≤ 24.0 OK 100% under
On net area f_t ≤ F_t, 0.0 ≤ 44.0 OK 100% under

Design Member 31, wind on front, Compression

f_a ≤ F_a, 0.0 ≤ 20.615 OK 100% under

Design Member 31, wind on front, Bending + Tension

f_y = F_y / (F_x + F_b + F_y / F_y) = 0.0 / 24.0 + 0.111 / 26.4 + 3.875 / 26.4 = 0.151 ≤ 1 OK 85% under

Design Member 31, wind on front, Bending + Compression

f_a = F_a / 0.20.615 = 0.0 ≤ 0.15 ≤ φ_0

φ_a = φ_x + φ_y + φ_z + φ_w = 0.0 / 20.615 + 0.111 / 26.4 + 3.875 / 26.4 = 0.151 ≤ 1 OK 85% under

Load Case: climber

F_y = 40.0 ksi
On gross area F_t = 0.6 * F_y = 0.6 * 40.0 = 24.0 ksi
On net area F_t = 0.5 * F_u = 0.5 * 88.0 = 44.0 ksi
F_y = 0.4 + F_y = 0.4 + 40.0 = 16.0 ksi
K_l/r = max(K_x/l/r_x, K_y/l/r_y) = max(1.0 * 26.5/0.586, 1.0 * 26.5/0.586) = 45.222
Calc by: FJC


\[ F_a = \left(1 - \frac{(KL/r)^2}{(2+Cc^2)}\right) \times F_y \times \frac{FS}{(1-45.222^2/(2+119.63^2)) \times 40.0/1.802 = 20.615 \text{ ksi}} \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 31, climber, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.027 \leq 26.4 \text{ OK 100}\% \text{ under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.027 \leq 26.4 \text{ OK 100}\% \text{ under} \]

**Design Member 31, climber, Major Shear**
\[ f_v \leq F_v, \ 0.001 \leq 16.0 \text{ OK 100}\% \text{ under} \]

**Design Member 31, climber, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100}\% \text{ under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.0 \leq 26.4 \text{ OK 100}\% \text{ under} \]

**Design Member 31, climber, Minor Shear**
\[ f_v \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100}\% \text{ under} \]

**Design Member 31, climber, Compression**
\[ f_v \leq F_v, \ 0.0 \leq 20.615 \text{ OK 100}\% \text{ under} \]

**Design Member 31, climber, Bending + Tension**
\[ f_b/F_b + f_b/F_b + f_v/F_v = 0.0/0.0 + 0.27/26.4 + 0.0/26.4 = 0.001 \leq 1 \text{ OK 100}\% \text{ under} \]

**Design Member 31, climber, Bending + Compression**
\[ f_b/F_b = 0.0/20.615 = 0.0 \leq 0.15 \phi_0 \]
\[ \phi_a = \phi_k + \phi_k + \phi_k + \phi_k = 0.0/20.615 + 0.027/26.4 + 0.0/26.4 = 0.001 \leq 1 \text{ OK 100}\% \text{ under} \]

**Load Case: wind on back**
\[ F_y = 40.0 \text{ ksi} \]
- On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100}\% \text{ under} \)
- On net area \( f_t \leq F_t, \ 0.0 \leq 44.0 \text{ OK 100}\% \text{ under} \)

**Design Member 31, wind on back, Major Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.111 \leq 26.4 \text{ OK 100}\% \text{ under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.111 \leq 26.4 \text{ OK 100}\% \text{ under} \]

**Design Member 31, wind on back, Major Shear**
\[ f_v \leq F_v, \ 0.004 \leq 16.0 \text{ OK 100}\% \text{ under} \]

**Design Member 31, wind on back, Minor Bending**
- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 3.875 \leq 26.4 \text{ OK 85}\% \text{ under} \]
- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 3.875 \leq 26.4 \text{ OK 85}\% \text{ under} \]

**Design Member 31, wind on back, Minor Shear**
\[ f_v \leq F_v, \ 0.178 \leq 16.0 \text{ OK 99}\% \text{ under} \]

**Design Member 31, wind on back, Tension**
- On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100}\% \text{ under} \)
Calc by: FJC  
AquaClimb  
11/24/2009

Checked by:  
GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK $100\%$ under

**Design Member 31, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 20.615$ OK $100\%$ under

**Design Member 31, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 0.111/26.4 + 3.875/26.4 = 0.151 \leq 1$ OK $85\%$ under

**Design Member 31, wind on back, Bending + Compression**

$f_a/F_a = 0.0/20.615 = 0.0 \leq 0.15 \Rightarrow \phi_0$

$\phi_a/\Phi_\alpha + \phi_{bz}/\Phi_{\beta z} + \phi_{by}/\Phi_{\beta y} = 0.0/20.615 + 0.111/26.4 + 3.875/26.4 = 0.151 \leq 1$ OK $85\%$ under
Checking design member 32

Members: 32
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\( F_y = 40.0 \text{ ksi} \)

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\( K_l/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 15.0 / 0.586, 1.0 \times 15.0 / 0.586) = 25.597 \)

\( F_a = (1 - (K_l/r)^2 / (2 \times C_c^2)) \times F_y / FS = (1 - 25.597^2 / (2 \times 119.63^2)) \times 40.0 / 1.746 = 22.389 \text{ ksi} \)

Major Axis:
\( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

Minor Axis:
\( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

Design Member 32, wind on front, Major Bending

Tensile Bending Stress:
\( f_b \leq F_b, \quad 8.772 \leq 26.4 \text{ OK 67% under} \)

Compressive Bending Stress:
\( f_b \leq F_b, \quad 8.772 \leq 26.4 \text{ OK 67% under} \)

Design Member 32, wind on front, Major Shear
\( f_v \leq F_v, \quad 0.081 \leq 16.0 \text{ OK 99% under} \)

Design Member 32, wind on front, Minor Bending

Tensile Bending Stress:
\( f_b \leq F_b, \quad 1.283 \leq 26.4 \text{ OK 95% under} \)

Compressive Bending Stress:
\( f_b \leq F_b, \quad 1.283 \leq 26.4 \text{ OK 95% under} \)

Design Member 32, wind on front, Minor Shear
\( f_v \leq F_v, \quad 0.145 \leq 16.0 \text{ OK 99% under} \)

Design Member 32, wind on front, Tension

On gross area \( f_t \leq F_t, \quad 0.181 \leq 24.0 \text{ OK 99% under} \)

On net area \( f_t \leq F_t, \quad 0.181 \leq 44.0 \text{ OK 100% under} \)

Design Member 32, wind on front, Compression
\( f_a \leq F_a, \quad 0.0 \leq 22.389 \text{ OK 100% under} \)

Design Member 32, wind on front, Bending + Tension
\( f_y / (F_t / F_y / F_{bx} + f_y / F_{by}) / F_{by} = 0.181 / 24.0 + 8.772 / 26.4 + 1.283 / 26.4 = 0.388 \leq 1 \text{ OK 61% under} \)

Design Member 32, wind on front, Bending + Compression
\( f_y / F_a = 0.0 / 22.389 = 0.0 \leq 0.15 \therefore \phi_0 \)
\( \phi_0 / \Phi_0 + \phi_{\text{bx}} / \Phi_{\text{bx}} + \phi_{\text{by}} / \Phi_{\text{by}} = 0.0 / 22.389 + 8.772 / 26.4 + 1.283 / 26.4 = 0.381 \leq 1 \text{ OK 62% under} \)

Load Case: climber
\( F_y = 40.0 \text{ ksi} \)

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\( K_l/r = \max(K_x \times l/r, K_y \times l/r) = \max(1.0 \times 15.0 / 0.586, 1.0 \times 15.0 / 0.586) = 25.597 \)
Calc by: FJC

AquaClimb

11/24/2009

\[ F_a = (1 - (KL/r)^2/(2 + Cc^2)) \times F_y/FS = (1 - 25.597^2/(2 + 119.63^2)) \times 40.0/1.746 = 22.389 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 32, climber, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_b, 3.196 \leq 26.4 \text{ OK 88\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 3.196 \leq 26.4 \text{ OK 88\% under} \)

**Design Member 32, climber, Major Shear**

\( f_s \leq F_s, 0.095 \leq 16.0 \text{ OK 99\% under} \)

**Design Member 32, climber, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_b, 0.442 \leq 26.4 \text{ OK 98\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 0.442 \leq 26.4 \text{ OK 98\% under} \)

**Design Member 32, climber, Minor Shear**

\( f_s \leq F_s, 0.044 \leq 16.0 \text{ OK 100\% under} \)

**Design Member 32, climber, Tension**

- On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100\% under} \)
- On net area \( f_t \leq F_t, 0.0 \leq 44.0 \text{ OK 100\% under} \)

**Design Member 32, climber, Compression**

\( f_a \leq F_a, 0.045 \leq 22.389 \text{ OK 100\% under} \)

**Design Member 32, climber, Bending + Tension**

\( f_y/F_y + f_x/F_x + f_y/F_y = 0.0 + 0.6 + 0.6 = 1.2 \text{ OK 86\% under} \)

**Design Member 32, climber, Bending + Compression**

\( f_y/F_y = 0.045/22.389 = 0.022 \text{ \( \phi_0 \)} \)

\[ \phi_\alpha + \phi_\beta + \phi_\gamma / F_y \leq 0.045/22.389 + 3.196/26.4 + 0.442/26.4 = 0.14 \text{ OK 86\% under} \]

**Load Case: wind on back**

\( F_y = 40.0 \text{ ksi} \)

- On gross area \( f_t \leq F_t, 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area \( f_t \leq F_t, 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\( KL/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 15.0, 0.586, 1.0 \times 15.0, 0.586) = 25.597 \)

\( F_a = (1 - (KL/r)^2/(2 + Cc^2)) \times F_y/FS = (1 - 25.597^2/(2 + 119.63^2)) \times 40.0/1.746 = 22.389 \text{ ksi} \)

**Major Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 32, wind on back, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_b, 8.772 \leq 26.4 \text{ OK 67\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 8.772 \leq 26.4 \text{ OK 67\% under} \)

**Design Member 32, wind on back, Major Shear**

\( f_s \leq F_s, 0.081 \leq 16.0 \text{ OK 99\% under} \)

**Design Member 32, wind on back, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_b, 1.283 \leq 26.4 \text{ OK 95\% under} \)
- Compressive Bending Stress: \( f_b \leq F_b, 1.283 \leq 26.4 \text{ OK 95\% under} \)

**Design Member 32, wind on back, Minor Shear**

\( f_s \leq F_s, 0.145 \leq 16.0 \text{ OK 99\% under} \)

**Design Member 32, wind on back, Tension**

- On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100\% under} \)
On net area $f_t \leq F_t$, 0.0 $\leq$ 44.0 OK 100% under

**Design Member 32, wind on back, Compression**

$f_a \leq F_a$, 0.181 $\leq$ 22.389 OK 99% under

**Design Member 32, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 8.772/26.4 + 1.283/26.4 = 0.381 \leq 1$ OK 62% under

**Design Member 32, wind on back, Bending + Compression**

$f_a/F_a = 0.181/22.389 = 0.008 \leq 0.15 \therefore \phi_0$

$\phi_a/\phi_a + \phi_{lz}/\phi_{lz} + \phi_{tw}/\phi_{tw} = 0.181/22.389 + 8.772/26.4 + 1.283/26.4 = 0.389 \leq 1$ OK 61% under
Checking design member 33

Members: 33
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]
- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
- \( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)
- \( K_l/r = \max(K_x \times l/r, K_y \times l/y) = \max(1.0 \times 4.0 / 0.586, 1.0 \times 4.0 / 0.586) = 6.826 \)

Design Member 33, wind on front, Major Bending

**Tensile Bending Stress:**
- \( f_b \leq F_b, 10.751 \leq 26.4 \text{ OK 59\% under} \)
- **Compressive Bending Stress:**
- \( f_b \leq F_b, 10.751 \leq 26.4 \text{ OK 59\% under} \)

Design Member 33, wind on front, Minor Bending

**Tensile Bending Stress:**
- \( f_b \leq F_b, 1.146 \leq 26.4 \text{ OK 96\% under} \)
- **Compressive Bending Stress:**
- \( f_b \leq F_b, 1.146 \leq 26.4 \text{ OK 96\% under} \)

Design Member 33, wind on front, Minor Shear

- \( f_v \leq F_v, 0.19 \leq 16.0 \text{ OK 99\% under} \)

Design Member 33, wind on front, Tension

- On gross area \( f_t \leq F_t, 0.508 \leq 24.0 \text{ OK 98\% under} \)
- On net area \( f_t \leq F_t, 0.508 \leq 44.0 \text{ OK 99\% under} \)

Design Member 33, wind on front, Compression

- \( f_a \leq F_a, 0.0 \leq 23.658 \text{ OK 100\% under} \)

Design Member 33, wind on front, Bending + Tension

- \( f_y/F_t + f_{tx}/F_{tx} + f_{ty}/F_{ty} = 0.508/24.0 + 10.751/26.4 + 1.146/26.4 = 0.472 \leq 1 \text{ OK 53\% under} \)

Design Member 33, wind on front, Bending + Compression

- \( f_y/F_a = 0.0/23.658 = 0.0 \leq 0.15 \text{ :OK} \)
- \( f_{tx}/F_{tx} + f_{ty}/F_{ty} = 0.0/23.658 + 10.751/26.4 + 1.146/26.4 = 0.451 \leq 1 \text{ OK 55\% under} \)

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]
- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
- \( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)
- \( K_l/r = \max(K_x \times l/r, K_y \times l/y) = \max(1.0 \times 4.0 / 0.586, 1.0 \times 4.0 / 0.586) = 6.826 \)
F_a = (1 - (KL/r)^2/(2 + Cc^2)) * F_y / FS = (1 - 6.826^2/(2 + 119.63^2)) * 40.0 / 1.688 = 23.658 ksi

Major Axis:
F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 ksi
Minor Axis:
F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 ksi

**Design Member 33, climber, Major Bending**

Tensile Bending Stress:
f_b ≤ F_b, 3.196 ≤ 26.4 OK 88% under

Compressive Bending Stress:
f_b ≤ F_b, 3.196 ≤ 26.4 OK 88% under

**Design Member 33, climber, Major Shear**

f_s ≤ F_s, 1.257 ≤ 16.0 OK 92% under

**Design Member 33, climber, Minor Bending**

Tensile Bending Stress:
f_b ≤ F_b, 0.535 ≤ 26.4 OK 98% under

Compressive Bending Stress:
f_b ≤ F_b, 0.535 ≤ 26.4 OK 98% under

**Design Member 33, climber, Minor Shear**

f_s ≤ F_s, 0.062 ≤ 16.0 OK 100% under

**Design Member 33, climber, Tension**

On gross area f_t ≤ F_t, 0.0 ≤ 24.0 OK 100% under

On net area f_t ≤ F_t, 0.0 ≤ 44.0 OK 100% under

**Design Member 33, climber, Compression**

f_a ≤ F_a, 0.178 ≤ 23.658 OK 99% under

**Design Member 33, climber, Bending + Tension**

f_o/F_y = 0.0 / 44.0 + 3.196 / 26.4 + 0.535 / 26.4 = 0.141 ≤ 1 OK 86% under

**Design Member 33, climber, Bending + Compression**

f_A/F_A = 0.178 / 23.658 = 0.008 ≤ 0.15 : φ_0

φ_α / φ_β = φ_α / φ_β = φ_α / φ_β = 0.178 / 23.658 + 3.196 / 26.4 + 0.535 / 26.4 = 0.149 ≤ 1 OK 85% under

**Load Case: wind on back**

F_y = 40.0 ksi

On gross area F_t = 0.6 * F_y = 0.6 * 40.0 = 24.0 ksi

On net area F_t = 0.5 * F_u = 0.5 * 88.0 = 44.0 ksi

F_v = 0.4 * F_y = 0.4 * 40.0 = 16.0 ksi

KL/r = max(K_x * l/r_x, K_y * l/r_y) = max(1.0 * 4.0 / 0.586; 1.0 * 4.0 / 0.586) = 6.826

F_a = (1 - (KL/r)^2/(2 + Cc^2)) * F_y / FS = (1 - 6.826^2/(2 + 119.63^2)) * 40.0 / 1.688 = 23.658 ksi

Major Axis:
F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 ksi
Minor Axis:
F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 ksi

**Design Member 33, wind on back, Major Bending**

Tensile Bending Stress:
f_b ≤ F_b, 10.751 ≤ 26.4 OK 59% under

Compressive Bending Stress:
f_b ≤ F_b, 10.751 ≤ 26.4 OK 59% under

**Design Member 33, wind on back, Major Shear**

f_s ≤ F_s, 4.348 ≤ 16.0 OK 73% under

**Design Member 33, wind on back, Minor Bending**

Tensile Bending Stress:
f_b ≤ F_b, 1.146 ≤ 26.4 OK 96% under

Compressive Bending Stress:
f_b ≤ F_b, 1.146 ≤ 26.4 OK 96% under

**Design Member 33, wind on back, Minor Shear**

f_s ≤ F_s, 0.19 ≤ 16.0 OK 99% under

**Design Member 33, wind on back, Tension**

On gross area f_t ≤ F_t, 0.0 ≤ 24.0 OK 100% under
On net area $f_i \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 33, wind on back, Compression**

$f_a \leq F_a$, $0.508 \leq 23.658$ OK 98% under

**Design Member 33, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 10.751/26.4 + 1.146/26.4 = 0.451 \leq 1$ OK 55% under

**Design Member 33, wind on back, Bending + Compression**

$f_a/F_a = 0.508/23.658 = 0.021 \leq 0.15 \implies \phi_0$

$\phi_{\alpha}/\Phi_{\alpha} + \phi_{\beta}/\Phi_{\beta} + \phi_{\gamma}/\Phi_{\gamma} = 0.508/23.658 + 10.751/26.4 + 1.146/26.4 = 0.472 \leq 1$ OK 53% under
Checking design member 34

Members: 34
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\( F_y = 40.0 \text{ ksi} \)

On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\( K_l/r = \max(K_x*l/r, K_y*l/r) = \max(1.0 \times 15.0/0.586, 1.0 \times 15.0/0.586) = 25.597 \)

\( F_a = (1 - (K_l/r)^2/(2 \times Cc^2)) \times F_y/FS = (1 - 25.597^2/(2 \times 119.63^2)) \times 40.0/1.746 = 22.389 \text{ ksi} \)

**Major Axis:**

\( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

**Minor Axis:**

\( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

**Design Member 34, wind on front, Major Bending**

Tensile Bending Stress:

\( f_b \leq F_b, 8.772 \leq 26.4 \text{ OK 67% under} \)

Compressive Bending Stress:

\( f_b \leq F_b, 8.772 \leq 26.4 \text{ OK 67% under} \)

**Design Member 34, wind on front, Major Shear**

\( f_v \leq F_v, 0.081 \leq 16.0 \text{ OK 99% under} \)

**Design Member 34, wind on front, Minor Bending**

Tensile Bending Stress:

\( f_b \leq F_b, 1.283 \leq 26.4 \text{ OK 95% under} \)

Compressive Bending Stress:

\( f_b \leq F_b, 1.283 \leq 26.4 \text{ OK 95% under} \)

**Design Member 34, wind on front, Minor Shear**

\( f_v \leq F_v, 0.145 \leq 16.0 \text{ OK 99% under} \)

**Design Member 34, wind on front, Tension**

On gross area \( f_t \leq F_y, 0.181 \leq 24.0 \text{ OK 99% under} \)

On net area \( f_t \leq F_u, 0.181 \leq 44.0 \text{ OK 100% under} \)

**Design Member 34, wind on front, Compression**

\( f_u \leq F_u, 0.0 \leq 22.389 \text{ OK 100% under} \)

**Design Member 34, wind on front, Bending + Tension**

\( f_y/F_u/F_b/F_v = 0.181/24.0 + 8.772/26.4 + 1.283/26.4 = 0.388 \leq 1 \text{ OK 61% under} \)

**Design Member 34, wind on front, Bending + Compression**

\( f_y/F_a = 0.0/22.389 = 0.0 \leq 0.15 \phi_0 \)

\( \phi_0 = 0.0/22.389 + 8.772/26.4 + 1.283/26.4 = 0.381 \leq 1 \text{ OK 62% under} \)

Load Case: climber

\( F_y = 40.0 \text{ ksi} \)

On gross area \( F_y = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)

On net area \( F_y = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\( K_l/r = \max(K_x*l/r, K_y*l/r) = \max(1.0 \times 15.0/0.586, 1.0 \times 15.0/0.586) = 25.597 \)
Calc by: FJC
AquaClimb 11/24/2009

Checked by: Gary K. Munkelet & Associates – Structural Engineers
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\[ F_a = (1 - (KL/r)^2/(2+Cc^2)) \times F_y / FS = (1 - 25.597^2/(2+119.63^2)) \times 40.0 / 1.746 = 22.389 \text{ ksi} \]

**Major Axis:**
- \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)
- \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

**Design Member 34, climber, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_b \), 3.196 \leq 26.4 OK 88% under
- Compressive Bending Stress: \( f_b \leq F_b \), 3.196 \leq 26.4 OK 88% under

**Design Member 34, climber, Major Shear**
- \( f_s \leq F_s \), 0.095 \leq 16.0 OK 99% under

**Design Member 34, climber, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_b \), 0.442 \leq 26.4 OK 98% under
- Compressive Bending Stress: \( f_b \leq F_b \), 0.442 \leq 26.4 OK 98% under

**Design Member 34, climber, Minor Shear**
- \( f_s \leq F_s \), 0.044 \leq 16.0 OK 100% under

**Design Member 34, climber, Tension**

- On gross area \( f_t \leq F_t \), 0.0 \leq 24.0 OK 100% under
- On net area \( f_t \leq F_t \), 0.0 \leq 44.0 OK 100% under

**Design Member 34, climber, Compression**
- \( f_c \leq F_c \), 0.045 \leq 22.389 OK 100% under

**Design Member 34, climber, Bending + Tension**
- \( f_t/F_t + f_b/F_b + f_y/F_y = 0.0/44.0 + 3.196/26.4 + 0.442/26.4 = 0.138 \leq 1 \text{ OK 86% under} \)

**Design Member 34, climber, Bending + Compression**
- \( f_t/F_t = 0.045/22.389 = 0.002 \leq 0.15 \Rightarrow \phi_0 \)
- \( \phi_u/\phi_a + \phi_{ps}/\phi_{ps} + \phi_{ps}/\phi_{ps} = 0.045/22.389 + 3.196/26.4 + 0.442/26.4 = 0.14 \leq 1 \text{ OK 86% under} \)

**Load Case: wind on back**

- \( F_y = 40.0 \text{ ksi} \)
- On gross area \( f_t \leq F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
- On net area \( f_t \leq F_t = 0.5 \times F_y = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
- \( F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)
- \( KL/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 15.0, 1.0 \times 15.0) = 15.0 \)
- \( F_a = (1 - (KL/r)^2/(2+Cc^2)) \times F_y / FS = (1 - 25.597^2/(2+119.63^2)) \times 40.0 / 1.746 = 22.389 \text{ ksi} \)
- **Major Axis:**
  - \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)
  - \( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

**Design Member 34, wind on back, Major Bending**

- Tensile Bending Stress: \( f_b \leq F_b \), 8.772 \leq 26.4 OK 67% under
- Compressive Bending Stress: \( f_b \leq F_b \), 8.772 \leq 26.4 OK 67% under

**Design Member 34, wind on back, Major Shear**
- \( f_s \leq F_s \), 0.081 \leq 16.0 OK 99% under

**Design Member 34, wind on back, Minor Bending**

- Tensile Bending Stress: \( f_b \leq F_b \), 1.283 \leq 26.4 OK 95% under
- Compressive Bending Stress: \( f_b \leq F_b \), 1.283 \leq 26.4 OK 95% under

**Design Member 34, wind on back, Minor Shear**
- \( f_s \leq F_s \), 0.145 \leq 16.0 OK 99% under

**Design Member 34, wind on back, Tension**

- On gross area \( f_t \leq F_t \), 0.0 \leq 24.0 OK 100% under
On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 34, wind on back, Compression**

$f_a \leq F_a$, $0.181 \leq 22.389$ OK 99% under

**Design Member 34, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 8.772/26.4 + 1.283/26.4 = 0.381 \leq 1$ OK 62% under

**Design Member 34, wind on back, Bending + Compression**

$f_a/F_a = 0.181/22.389 = 0.008 \leq 0.15 \therefore \phi^0$

$\Phi_\alpha + \Phi_\beta + \Phi_\gamma + \Phi_\delta = 0.181/22.389 + 8.772/26.4 + 1.283/26.4 = 0.389 \leq 1$ OK 61% under
Checking design member 35

Members: 35
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\( F_y = 40.0 \) ksi

- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \) ksi
- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \) ksi

\( F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \) ksi

\( K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 4.0 / 0.586, 1.0 \times 4.0 / 0.586) = 6.826 \)

**Major Axis:**

\( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \) ksi

**Minor Axis:**

\( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \) ksi

**Design Member 35, wind on front, Major Bending**

- Tensile Bending Stress:
  \( f_b \leq F_b \), 10.751 \leq 26.4 OK 59% under

- Compressive Bending Stress:
  \( f_b \leq F_b \), 10.751 \leq 26.4 OK 59% under

**Design Member 35, wind on front, Major Shear**

\( f_v \leq F_v \), 4.348 \leq 16.0 OK 73% under

**Design Member 35, wind on front, Minor Bending**

- Tensile Bending Stress:
  \( f_b \leq F_b \), 1.146 \leq 26.4 OK 96% under

- Compressive Bending Stress:
  \( f_b \leq F_b \), 1.146 \leq 26.4 OK 96% under

**Design Member 35, wind on front, Minor Shear**

\( f_v \leq F_v \), 0.19 \leq 16.0 OK 99% under

**Design Member 35, wind on front, Tension**

- On gross area \( f_t \leq F_t \), 0.508 \leq 24.0 OK 98% under

- On net area \( f_t \leq F_t \), 0.508 \leq 44.0 OK 99% under

**Design Member 35, wind on front, Compression**

\( f_a \leq F_a \), 0.0 \leq 23.658 OK 100% under

**Design Member 35, wind on front, Bending + Tension**

\( f_y/F_t + f_b/F_b + f_v/F_v = 0.508/24.0 + 10.751/26.4 + 4.348/26.4 = 0.472 \leq 1 \) OK 53% under

**Design Member 35, wind on front, Bending + Compression**

\( f_y/F_a + f_b/F_b + f_v/F_v = 0.0/23.658 + 1.146/26.4 + 0.19/16.0 = 0.451 \leq 1 \) OK 55% under

Load Case: climber

\( F_y = 40.0 \) ksi

- On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \) ksi

- On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \) ksi

\( F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \) ksi

\( K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 4.0 / 0.586, 1.0 \times 4.0 / 0.586) = 6.826 \)
Calc by: FJC

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\[ F_a = \left(1 - \frac{(Kl/r)^2}{(2+2C_c^2)}\right) + \frac{F_y/FS}{(1 - 6.826^2/\left(2+119.63^2\right))} + 40.0/1.688 = 23.658 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66+F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66+F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Design Member 35, climber, Major Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, 3.196 \leq 26.4 \text{ OK 88\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 3.196 \leq 26.4 \text{ OK 88\% under} \]

**Design Member 35, climber, Major Shear**

\[ f_s \leq F_s, 1.257 \leq 16.0 \text{ OK 92\% under} \]

**Design Member 35, climber, Minor Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, 0.535 \leq 26.4 \text{ OK 98\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 0.535 \leq 26.4 \text{ OK 98\% under} \]

**Design Member 35, climber, Minor Shear**

\[ f_s \leq F_s, 0.062 \leq 16.0 \text{ OK 100\% under} \]

**Design Member 35, climber, Tension**

On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100\% under} \)

On net area \( f_t \leq F_t, 0.0 \leq 44.0 \text{ OK 100\% under} \)

**Design Member 35, climber, Compression**

\[ f_a = 0.178 \leq 23.658 \text{ OK 99\% under} \]

**Load Case: wind on back**

\[ F_y = 40.0 \text{ ksi} \]

On gross area \( F_t = 0.6+F_y, 0.6+40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5+F_u, 0.5+88.0 = 44.0 \text{ ksi} \)

\[ F_v = 0.4+F_y = 0.4+40.0 = 44.0 \text{ ksi} \]

\[ Kl/r = \max(K_x x/l, K_y y/l) = \max(1.0 \times 4.0/0.586, 1.0 \times 4.0/0.586) = 6.826 \]

\[ F_a = \left(1 - \frac{(Kl/r)^2}{(2+2C_c^2)}\right) + \frac{F_y/FS}{(1 - 6.826^2/\left(2+119.63^2\right))} + 40.0/1.688 = 23.658 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66+F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66+F_y = 0.66 + 40.0 = 26.4 \text{ ksi} \]

**Design Member 35, wind on back, Major Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, 10.751 \leq 26.4 \text{ OK 59\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 10.751 \leq 26.4 \text{ OK 59\% under} \]

**Design Member 35, wind on back, Major Shear**

\[ f_s \leq F_s, 4.348 \leq 16.0 \text{ OK 73\% under} \]

**Design Member 35, wind on back, Minor Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, 1.146 \leq 26.4 \text{ OK 96\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 1.146 \leq 26.4 \text{ OK 96\% under} \]

**Design Member 35, wind on back, Minor Shear**

\[ f_s \leq F_s, 0.19 \leq 16.0 \text{ OK 99\% under} \]

**Design Member 35, wind on back, Tension**

On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100\% under} \)
On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 35, wind on back, Compression**

$f_a \leq F_a$, $0.508 \leq 23.658$ OK 98% under

**Design Member 35, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 10.751/26.4 + 1.146/26.4 = 0.451 \leq 1$ OK 55% under

**Design Member 35, wind on back, Bending + Compression**

$f_a/F_a = 0.508/23.658 = 0.021 \leq 0.15 \therefore \phi$

$\phi_{\alpha}/\phi_{\alpha} + \phi_{\beta x}/\phi_{\beta x} + \phi_{\beta y}/\phi_{\beta y} = 0.508/23.658 + 10.751/26.4 + 1.146/26.4 = 0.472 \leq 1$ OK 53% under
Checking design member 36
Members: 36
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front
\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)
\( K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 2.0 / 0.586, 1.0 \times 2.0 / 0.586) = 3.413 \)
\( F_a = (1 - (K_l/r)^2) \times F_y / F_S = (1 - 3.413^2 / (2 \times 119.63^2)) \times 40.0 / 1.677 = 23.837 \text{ ksi} \)

Major Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Minor Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Design Member 36, wind on front, Major Bending
Tensile Bending Stress:
\[ f_b \leq F_b, 5.545 \leq 26.4 \text{ OK 79\% under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, 5.545 \leq 26.4 \text{ OK 79\% under} \]

Design Member 36, wind on front, Major Shear
\[ f_v \leq F_v, 4.428 \leq 16.0 \text{ OK 72\% under} \]

Design Member 36, wind on front, Minor Bending
Tensile Bending Stress:
\[ f_b \leq F_b, 3.309 \leq 26.4 \text{ OK 87\% under} \]
Compressive Bending Stress:
\[ f_b \leq F_b, 3.309 \leq 26.4 \text{ OK 87\% under} \]

Design Member 36, wind on front, Minor Shear
\[ f_v \leq F_v, 2.151 \leq 16.0 \text{ OK 87\% under} \]

Design Member 36, wind on front, Tension
On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100\% under} \)
On net area \( f_t \leq F_n, 0.0 \leq 44.0 \text{ OK 100\% under} \)

Design Member 36, wind on front, Compression
\[ f_a \leq F_a, 0.125 \leq 23.837 \text{ OK 99\% under} \]

Design Member 36, wind on front, Bending + Tension
\[ f_y / F_t + f_b \times F_{bx} + f_b / F_{by} = 0.0 / 44.0 + 5.545 / 26.4 + 3.309 / 26.4 = 0.335 \leq 1 \text{ OK 66\% under} \]

Design Member 36, wind on front, Bending + Compression
\[ f_y / F_a = 0.125 / 23.837 = 0.005 \leq 0.15 : \phi_0 \]
\[ \phi_y / \phi_a + \phi_{by} / \phi_{by} + \phi_{bc} / \phi_{bc} = 0.125 / 23.837 + 5.545 / 26.4 + 3.309 / 26.4 = 0.341 \leq 1 \text{ OK 66\% under} \]

Load Case: climber
\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]
\( K_l/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 2.0 / 0.586, 1.0 \times 2.0 / 0.586) = 3.413 \)
Calc by: FJC  AquaClimb  11/24/2009

Checked by: GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

\[ \text{Fa} = (1 - (KL/r)^2/(2+Cc^2)) * F_y / \text{FS} = (1 - 3.413^2/(2+119.63^2)) * 40.0 / 1.677 = 23.837 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 \text{ ksi} \]

**Design Member 36, climber, Major Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 1.247 \leq 26.4 \text{ OK 95\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 1.247 \leq 26.4 \text{ OK 95\% under} \]

**Design Member 36, climber, Major Shear**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.701 \leq 16.0 \text{ OK 96\% under} \]

**Design Member 36, climber, Minor Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.446 \leq 26.4 \text{ OK 98\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 0.446 \leq 26.4 \text{ OK 98\% under} \]

**Design Member 36, climber, Minor Shear**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 0.258 \leq 16.0 \text{ OK 98\% under} \]

**Load Case: wind on back**

- \( F_y = 40.0 \text{ ksi} \)

- On gross area \( f_t \leq F_t, \ 0.125 \leq 24.0 \text{ OK 99\% under} \)

- On net area \( f_t \leq F_t, \ 0.005 \leq 44.0 \text{ OK 100\% under} \)

**Design Member 36, climber, Compression**

\[ \frac{f_a}{F_a} = 0.0 / 23.837 = 0.0 \leq 0.15 \Rightarrow \phi_0 \]

\[ \phi_{\alpha}^\alpha + \phi_{p_{\beta}}^{\beta} + \phi_{\mu_{\gamma}}^{\gamma} / \phi_{\psi_{\delta}}^{\delta} = 0.0 / 23.837 + 1.247 / 26.4 + 0.446 / 26.4 = 0.064 \leq 1 \text{ OK 94\% under} \]

**Design Member 36, climber, Major Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 5.545 \leq 26.4 \text{ OK 79\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 5.545 \leq 26.4 \text{ OK 79\% under} \]

**Design Member 36, climber, Major Shear**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 4.428 \leq 16.0 \text{ OK 72\% under} \]

**Design Member 36, climber, Minor Bending**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 3.309 \leq 26.4 \text{ OK 87\% under} \]

- Compressive Bending Stress:
  \[ f_b \leq F_b, \ 3.309 \leq 26.4 \text{ OK 87\% under} \]

**Design Member 36, climber, Minor Shear**

- Tensile Bending Stress:
  \[ f_b \leq F_b, \ 2.151 \leq 16.0 \text{ OK 87\% under} \]

**Design Member 36, climber, Tension**

- On gross area \( f_t \leq F_t, \ 0.125 \leq 24.0 \text{ OK 99\% under} \)

**Load Case: wind on back**

- \( F_y = 40.0 \text{ ksi} \)

- On gross area \( F_t = 0.6 * F_y = 0.6 * 40.0 = 24.0 \text{ ksi} \)

- On net area \( F_t = 0.5 * F_u = 0.5 * 88.0 = 44.0 \text{ ksi} \)

\[ KL/r = \max(1.0 * 2.0 / 0.586, 1.0 * 2.0 / 0.586) = 3.413 \]

\[ F_a = (1 - (KL/r)^2/(2+Cc^2)) * F_y / \text{FS} = (1 - 3.413^2/(2+119.63^2)) * 40.0 / 1.677 = 23.837 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 * F_y = 0.66 * 40.0 = 26.4 \text{ ksi} \]
On net area $f_t \leq F_t$, 0.125 $\leq$ 44.0 OK 100% under

**Design Member 36, wind on back, Compression**

$f_a \leq F_a$, 0.0 $\leq$ 23.837 OK 100% under

**Design Member 36, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.125/24.0 + 5.545/26.4 + 3.309/26.4 = 0.341 \leq 1$ OK 66% under

**Design Member 36, wind on back, Bending + Compression**

$f_a/F_a = 0.0/23.837 = 0.0 \leq 0.15 \therefore \phi_0$

$\phi_0/\Phi_\alpha + \phi_{\beta x}/\Phi_{\beta x} + \phi_{\beta y}/\Phi_{\beta y} = 0.0/23.837 + 5.545/26.4 + 3.309/26.4 = 0.335 \leq 1$ OK 66% under
Checking design member 37

Members: 37
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

Load Case: climber
Load Case: wind on back

\[ F_y = 40.0 \text{ ksi} \]

\[ F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

\[ F_v = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ KL/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 8.0/0.586, 1.0 \times 8.0/0.586) = 13.652 \]

\[ F_a = (1 - (KL/r)^2/(2 + Cc^2)) \times F_y / FS = (1 - 13.652^2/(2 + 119.63^2)) \times 40.0 / 1.709 = 23.249 \text{ ksi} \]

**Major Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]
On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 37, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 23.249$ OK 100% under

**Design Member 37, wind on back, Bending + Tension**

$$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 5.545/26.4 + 1.52/26.4 = 0.268 \leq 1 \text{ OK 73% under}$$

**Design Member 37, wind on back, Bending + Compression**

$$f_a/F_a = 0.0/23.249 = 0.0 \leq 0.15 \therefore \phi$$

$$\phi/\Phi_{\alpha} + \phi_{\beta}/\Phi_{\beta} \leq \Phi_{\beta}/\Phi_{\beta} = 0.0/23.249 + 5.545/26.4 + 1.52/26.4 = 0.268 \leq 1 \text{ OK 73% under}$$
Checking design member 38

Members: 38
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]
\[ KL/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 2.0/0.586, 1.0 \times 2.0/0.586) = 3.413 \]
\[ F_a = (1 - (KL/r)^2/(2 \times Cc^2)) \times F_y / FS = (1 - 3.413^2/(2 \times 119.63^2)) \times 40.0/1.677 = 23.837 \text{ ksi} \]

Major Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Minor Axis:
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

Design Member 38, wind on front, Major Bending

Tensile Bending Stress:
\[ f_b \leq F_b, 5.545 \leq 26.4 \text{ OK 79\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 5.545 \leq 26.4 \text{ OK 79\% under} \]

Design Member 38, wind on front, Major Shear
\[ f_v \leq F_v, 4.428 \leq 16.0 \text{ OK 72\% under} \]

Design Member 38, wind on front, Minor Bending

Tensile Bending Stress:
\[ f_b \leq F_b, 3.309 \leq 26.4 \text{ OK 87\% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, 3.309 \leq 26.4 \text{ OK 87\% under} \]

Design Member 38, wind on front, Minor Shear
\[ f_v \leq F_v, 2.151 \leq 16.0 \text{ OK 87\% under} \]

Design Member 38, wind on front, Tension

On gross area \( f_t \leq F_t, 0.0 \leq 24.0 \text{ OK 100\% under} \)

On net area \( f_t \leq F_t, 0.0 \leq 44.0 \text{ OK 100\% under} \)

Design Member 38, wind on front, Compression
\[ f_a \leq F_a, 0.125 \leq 23.837 \text{ OK 99\% under} \]

Design Member 38, wind on front, Bending + Tension
\[ f_v/F_t + f_b/F_b + f_y/F_y = 0.0/44.0 + 5.545/26.4 + 3.309/26.4 = 0.335 \leq 1 \text{ OK 66\% under} \]

Design Member 38, wind on front, Bending + Compression
\[ f_a/F_a = 0.125/23.837 = 0.005 \leq 0.15 \text{ \phi} \]
\[ \phi_a = \phi_b = \phi_v = 0.125 \text{ \leq 23.837 + 5.545 + 3.309 + 0.335 = 1 OK 66\% under} \]

Load Case: climber

\[ F_y = 40.0 \text{ ksi} \]
On gross area \( F_t = 0.6 \times F_y = 0.6 \times 40.0 = 24.0 \text{ ksi} \)
On net area \( F_t = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)
\[ F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]
\[ KL/r = \max(K_x \times l/r_x, K_y \times l/r_y) = \max(1.0 \times 2.0/0.586, 1.0 \times 2.0/0.586) = 3.413 \]
Calc by: FJC

AquaClimb

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Checked by: GARY K. MUNKELT & ASSOCIATES – STRUCTURAL ENGINEERS

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\[ F_a = (1 - (KL/r)^2/(2 + Cc^2)) \cdot F_y/FS = (1 - 3.413^2/(2 + 119.63^2)) \cdot 40.0/1.677 = 23.837 \text{ ksi} \]

**Major Axis:**

\[ F_{b,x} = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_{b,y} = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Design Member 38, climber, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_{b,x} = 1.247 \leq 26.4 \text{ OK 95% under} \]

Compressive Bending Stress:

\[ f_b \leq F_{b,y} = 1.247 \leq 26.4 \text{ OK 95% under} \]

**Design Member 38, climber, Major Shear**

\[ f_s \leq F_v = 0.701 \leq 16.0 \text{ OK 96% under} \]

**Design Member 38, climber, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_{b,x} = 0.446 \leq 26.4 \text{ OK 98% under} \]

Compressive Bending Stress:

\[ f_b \leq F_{b,y} = 0.446 \leq 26.4 \text{ OK 98% under} \]

**Design Member 38, climber, Minor Shear**

\[ f_s \leq F_v = 0.258 \leq 16.0 \text{ OK 98% under} \]

**Design Member 38, climber, Tension**

On gross area \( f_t \leq F_t = 0.005 \leq 24.0 \text{ OK 100% under} \)

On net area \( f_t \leq F_n = 0.005 \leq 44.0 \text{ OK 100% under} \)

**Design Member 38, climber, Compression**

\( f_a \leq F_a = 0.0 \leq 23.837 \text{ OK 100% under} \)

**Design Member 38, climber, Bending + Tension**

\[ f_b/F_t + f_b/F_{b,x} + f_b/F_{b,y} = 0.005/24.0 + 1.247/26.4 + 0.446/26.4 = 0.064 \leq 1 \text{ OK 94% under} \]

**Design Member 38, climber, Bending + Compression**

\[ f_b/F_a = 0.0 \leq 0.15 \text{ under} \]

\[ \phi_a + \phi_{b,x} + \phi_{b,y} + \phi_v = 0.0 \leq 23.837 + 1.247/26.4 + 0.446/26.4 = 0.064 \leq 1 \text{ OK 94% under} \]

**Load Case: wind on back**

\( F_y = 40.0 \text{ ksi} \)

On gross area \( F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \)

On net area \( F_t = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \)

\( K_l/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 2.0/0.586, 1.0 \cdot 2.0/0.586) = 3.413 \)

\( F_a = (1 - (KL/r)^2/(2 + Cc^2)) \cdot F_y/FS = (1 - 3.413^2/(2 + 119.63^2)) \cdot 40.0/1.677 = 23.837 \text{ ksi} \)

**Major Axis:**

\[ F_{b,x} = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**

\[ F_{b,y} = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi} \]

**Design Member 38, wind on back, Major Bending**

Tensile Bending Stress:

\[ f_b \leq F_{b,x} = 5.545 \leq 26.4 \text{ OK 79% under} \]

Compressive Bending Stress:

\[ f_b \leq F_{b,y} = 5.545 \leq 26.4 \text{ OK 79% under} \]

**Design Member 38, wind on back, Major Shear**

\[ f_s \leq F_v = 4.428 \leq 16.0 \text{ OK 72% under} \]

**Design Member 38, wind on back, Minor Bending**

Tensile Bending Stress:

\[ f_b \leq F_{b,x} = 3.309 \leq 26.4 \text{ OK 87% under} \]

Compressive Bending Stress:

\[ f_b \leq F_{b,y} = 3.309 \leq 26.4 \text{ OK 87% under} \]

**Design Member 38, wind on back, Minor Shear**

\[ f_s \leq F_v = 2.151 \leq 16.0 \text{ OK 87% under} \]

**Design Member 38, wind on back, Tension**

On gross area \( f_t \leq F_t = 0.125 \leq 24.0 \text{ OK 99% under} \)
On net area $f_t \leq F_t$, $0.125 \leq 44.0$ OK 100% under

**Design Member 38, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 23.837$ OK 100% under

**Design Member 38, wind on back, Bending + Tension**

$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.125/24.0 + 5.545/26.4 + 3.309/26.4 = 0.341 \leq 1$ OK 66% under

**Design Member 38, wind on back, Bending + Compression**

$f_a/F_a = 0.0/23.837 = 0.0 \leq 0.15 \therefore \phi$

$\phi_\alpha \Phi_\alpha + \phi_\beta \Phi_\beta + \phi_\theta \Phi_\theta = 0.0/23.837 + 5.545/26.4 + 3.309/26.4 = 0.335 \leq 1$ OK 66% under
Checking design member 39

Members: 39
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

\( F_y = 40.0 \text{ ksi} \)

On gross area \( F_t = 0.6 \times F_y = 60.0 = 24.0 \text{ ksi} \)

On net area \( F_n = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\( KL/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 4.0/0.586, 1.0 \times 4.0/0.586) = 6.826 \)

\( F_a = (1 - (KL/r)^2/(2 \times Cc^2)) \times F_y/FS = (1 - 6.826^2/(2 \times 119.63^2)) \times 40.0/1.688 = 23.658 \text{ ksi} \)

Major Axis:
\( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

Minor Axis:
\( F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \)

Design Member 39, wind on front, Major Bending

Tensile Bending Stress:
\( f_b \leq F_b, 11.331 \leq 26.4 \text{ OK 57% under} \)

Compressive Bending Stress:
\( f_b \leq F_b, 11.331 \leq 26.4 \text{ OK 57% under} \)

Design Member 39, wind on front, Major Shear

\( f_v \leq F_v, 4.428 \leq 16.0 \text{ OK 72% under} \)

Design Member 39, wind on front, Minor Bending

Tensile Bending Stress:
\( f_b \leq F_b, 2.429 \leq 26.4 \text{ OK 91% under} \)

Compressive Bending Stress:
\( f_b \leq F_b, 2.429 \leq 26.4 \text{ OK 91% under} \)

Design Member 39, wind on front, Minor Shear

\( f_v \leq F_v, 0.635 \leq 16.0 \text{ OK 96% under} \)

Design Member 39, wind on front, Tension

On gross area \( f_t \leq F_t, 0.023 \leq 24.0 \text{ OK 100% under} \)

On net area \( f_t \leq F_n, 0.023 \leq 44.0 \text{ OK 100% under} \)

Design Member 39, wind on front, Compression

\( f_a \leq F_a, 0.0 \leq 23.658 \text{ OK 100% under} \)

Design Member 39, wind on front, Bending + Tension

\( f_v/F_a + f_b/F_bx + f_y/F_by = 0.023/24.0 + 11.331/26.4 + 2.429/26.4 = 0.522 \leq 1 \text{ OK 48% under} \)

Design Member 39, wind on front, Bending + Compression

\( f_a/F_a = 0.0/23.658 = 0.0 \leq 0.15 : f_0 \)

\( \phi_a/\phi_{\alpha} + \phi_{\beta} + \phi_{\gamma} + \phi_{\nu}/\phi_{\nu} = 0.0/23.658 + 11.331/26.4 + 2.429/26.4 = 0.521 \leq 1 \text{ OK 48% under} \)

Load Case: climber

\( F_y = 40.0 \text{ ksi} \)

On gross area \( F_t = 0.6 \times F_y = 60.0 = 24.0 \text{ ksi} \)

On net area \( F_n = 0.5 \times F_u = 0.5 \times 88.0 = 44.0 \text{ ksi} \)

\( F_y = 0.4 \times F_y = 0.4 \times 40.0 = 16.0 \text{ ksi} \)

\( KL/r = \max(K_x l/r_x, K_y l/r_y) = \max(1.0 \times 4.0/0.586, 1.0 \times 4.0/0.586) = 6.826 \)
Compressive Bending Stress: \( f_c \leq F_b \), 0.66 ≤ 26.4 OK 87% under

Tensile Bending Stress: \( f_t \leq F_b \), 3.486 ≤ 26.4 OK 87% under

Compressive Bending Stress: \( f_c \leq F_b \), 3.486 ≤ 26.4 OK 87% under

Design Member 39, climber, Major Bending
Tensile Bending Stress:
\( f_t \leq F_b \), 3.486 ≤ 26.4 OK 87% under

Compressive Bending Stress:
\( f_c \leq F_b \), 3.486 ≤ 26.4 OK 87% under

Design Member 39, climber, Minor Bending
Tensile Bending Stress:
\( f_t \leq F_b \), 0.977 ≤ 26.4 OK 96% under

Compressive Bending Stress:
\( f_c \leq F_b \), 0.977 ≤ 26.4 OK 96% under

Design Member 39, climber, Minor Shear
\( f_s \leq F_v \), 0.258 ≤ 16.0 OK 98% under

Design Member 39, climber, Tension
On gross area \( f_t \leq F_y \), 0.0 ≤ 24.0 OK 100% under

On net area \( f_t \leq F_y \), 0.0 ≤ 44.0 OK 100% under

Design Member 39, climber, Compression
\( f_s \leq F_a \), 0.009 ≤ 23.658 OK 100% under

Design Member 39, climber, Bending + Tension
\( f_t/F_y + f_b/F_b + f_0/F_0 = 0.0/44.0 + 3.486/26.4 + 0.977/26.4 = 0.169 \leq 1 \) OK 83% under

Design Member 39, climber, Bending + Compression
\( f_t/F_y = 0.009/23.658 = 0.015 < 1 \) OK 83% under

Load Case: wind on back

\( F_y = 40.0 \) ksi

On gross area \( F_t = 0.6 + F_y = 0.6 + 40.0 = 24.0 \) ksi

On net area \( F_t = 0.5 + F_u = 0.5 + 88.0 = 44.0 \) ksi

\( F_y = 0.4 + F_y = 0.4 + 40.0 = 44.0 \) ksi

\( KL/r = \max(K_r / l_r, K_r / l_r) = \max(1.0 + 4.0/0.586, 1.0 + 4.0/0.586) = 6.826 \)

\( F_a = (1 - (KL/r)^2 / (2+Cc^2)) + F_y / FS = (1 - 6.826^2 / (2 + 199.63^2)) + 40.0 / 1.688 = 23.658 \) ksi

Major Axis:
\( F_b = 0.66 + F_y = 0.66 + 40.0 = 26.4 \) ksi

\( Minor \ Axis: \)
\( F_b = 0.66 + F_y = 0.66 + 40.0 = 26.4 \) ksi

Design Member 39, wind on back, Major Bending
Tensile Bending Stress:
\( f_t \leq F_b \), 11.331 ≤ 26.4 OK 57% under

Compressive Bending Stress:
\( f_c \leq F_b \), 11.331 ≤ 26.4 OK 57% under

Design Member 39, wind on back, Major Shear
\( f_s \leq F_v \), 4.428 ≤ 16.0 OK 72% under

Design Member 39, wind on back, Minor Bending
Tensile Bending Stress:
\( f_t \leq F_b \), 2.429 ≤ 26.4 OK 91% under

Compressive Bending Stress:
\( f_c \leq F_b \), 2.429 ≤ 26.4 OK 91% under

Design Member 39, wind on back, Minor Shear
\( f_s \leq F_v \), 0.635 ≤ 16.0 OK 96% under

Design Member 39, wind on back, Tension
On gross area \( f_t \leq F_y \), 0.0 ≤ 24.0 OK 100% under
On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 39, wind on back, Compression**

$f_a \leq F_a$, $0.023 \leq 23.658$ OK 100% under

**Design Member 39, wind on back, Bending + Tension**

$\frac{f_a}{F_t} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} = 0.0/44.0 + 11.331/26.4 + 2.429/26.4 = 0.521 \leq 1$ OK 48% under

**Design Member 39, wind on back, Bending + Compression**

$\frac{f_a}{F_a} = 0.023/23.658 = 0.001 \leq 0.15 \therefore \phi_0$

$\phi_a/\Phi_\alpha + \phi_{bz}/\Phi_\beta_z + \phi_{by}/\Phi_\beta_y = 0.023/23.658 + 11.331/26.4 + 2.429/26.4 = 0.522 \leq 1$ OK 48% under
Checking design member 40

Members: 40
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

- Tensile Bending Stress:
  \( f_b \leq F_b \), 8.555 \leq 26.4 OK 68% under

- Compressive Bending Stress:
  \( f_b \leq F_b \), 8.555 \leq 26.4 OK 68% under

Design Member 40, wind on front, Major Shear

- \( f_v \leq F_v \), 0.0 \leq 16.0 OK 100% under

Design Member 40, wind on front, Minor Bending

- Tensile Bending Stress:
  \( f_b \leq F_b \), 0.423 \leq 26.4 OK 98% under

- Compressive Bending Stress:
  \( f_b \leq F_b \), 0.423 \leq 26.4 OK 98% under

Design Member 40, wind on front, Minor Shear

- \( f_v \leq F_v \), 0.0 \leq 16.0 OK 100% under

Design Member 40, wind on front, Tension

- On gross area \( f_t \leq F_t \), 0.0 \leq 24.0 OK 100% under

- On net area \( f_t \leq F_t \), 0.0 \leq 44.0 OK 100% under

Design Member 40, wind on front, Compression

- \( f_a \leq F_a \), 0.0 \leq 20.354 OK 100% under

Design Member 40, wind on front, Bending + Tension

- \( f_a/F_y = 0.0/40.0 = 0.0 \leq 44.0 + 0.423/26.4 = 0.34 \leq 1 \) OK 66% under

Design Member 40, wind on front, Bending + Compression

- \( f_a/F_y = 0.0/40.0 = 0.0 \leq 0.15 \cdot f_a \)

- \( \phi_a^{\text{fr}} + \phi_r^{\text{fr}} + \phi_c^{\text{fr}} + \phi_v^{\text{fr}} = 0.0/40.0 + 0.423/26.4 = 0.34 \leq 1 \) OK 66% under

Load Case: climber

- \( F_y = 40.0 \) ksi

- On gross area \( F_t = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \) ksi

- On net area \( F_t = 0.5 \cdot F_y = 0.5 \cdot 88.0 = 44.0 \) ksi

- \( F_v = 0.4 \cdot F_y = 0.4 \cdot 40.0 = 16.0 \) ksi

- \( K_l/r = \max(K_x \cdot l/r, K_y \cdot l/r) = \max(1.0 \cdot 28.0/0.586, 1.0 \cdot 28.0/0.586) = 47.782 \)
Calc by: FJC  
AquaClimb  
11/24/2009

\[ F_a = (1 - (KL/r)^2/(2+Cc^2)) \times F_y / FS = (1 - 47.782^2/(2+119.63^2)) \times 40.0 / 1.808 = 20.354 \text{ ksi} \]

**Major Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Minor Axis:**
\[ F_b = 0.66 \times F_y = 0.66 \times 40.0 = 26.4 \text{ ksi} \]

**Design Member 40, climber, Major Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, \ 2.586 \leq 26.4 \text{ OK 90% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, \ 2.586 \leq 26.4 \text{ OK 90% under} \]

**Design Member 40, climber, Major Shear**
\[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 40, climber, Minor Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, \ 0.181 \leq 26.4 \text{ OK 99% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, \ 0.181 \leq 26.4 \text{ OK 99% under} \]

**Design Member 40, climber, Minor Shear**
\[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 40, climber, Compression**
\[ f_s \leq F_a, \ 0.0 \leq 20.354 \text{ OK 100% under} \]

**Design Member 40, climber, Bending + Tension**
\[ f_a/F_a + f_b/F_b + f_s/F_s = 0.0/44.0 + 2.586/26.4 + 0.181/26.4 = 0.105 \leq 1 \text{ OK 90% under} \]

**Design Member 40, climber, Bending + Compression**
\[ f_a/F_a = 0.0/20.354 = 0.0 \leq 0.15 \text{ under} \]

\[ \Phi_x \Phi_y \Phi_z \Phi_p \Phi_q / \Phi_p = 0.0/20.354 + 2.586/26.4 + 0.181/26.4 = 0.105 \leq 1 \text{ OK 90% under} \]

**Load Case: wind on back**
\[ F_y = 40.0 \text{ ksi} \]

On gross area
\[ f_s \leq F_s, \ 0.0 \leq 24.0 \text{ OK 100% under} \]

On net area
\[ f_s \leq F_s, \ 0.0 \leq 44.0 \text{ OK 100% under} \]

**Design Member 40, wind on back, Major Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, \ 8.555 \leq 26.4 \text{ OK 68% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, \ 8.555 \leq 26.4 \text{ OK 68% under} \]

**Design Member 40, wind on back, Major Shear**
\[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 40, wind on back, Minor Bending**

Tensile Bending Stress:
\[ f_b \leq F_b, \ 0.423 \leq 26.4 \text{ OK 98% under} \]

Compressive Bending Stress:
\[ f_b \leq F_b, \ 0.423 \leq 26.4 \text{ OK 98% under} \]

**Design Member 40, wind on back, Minor Shear**
\[ f_s \leq F_v, \ 0.0 \leq 16.0 \text{ OK 100% under} \]

**Design Member 40, wind on back, Tension**

On gross area
\[ f_s \leq F_s, \ 0.0 \leq 24.0 \text{ OK 100% under} \]
On net area $f_t \leq F_t$, $0.0 \leq 44.0$ OK 100% under

**Design Member 40, wind on back, Compression**

$f_a \leq F_a$, $0.0 \leq 20.354$ OK 100% under

**Design Member 40, wind on back, Bending + Tension**

$f_a/F_t + f_{bx}/F_{bx} + f_{by}/F_{by} = 0.0/44.0 + 8.555/26.4 + 0.423/26.4 = 0.34 \leq 1$ OK 66% under

**Design Member 40, wind on back, Bending + Compression**

$f_a/F_a = 0.0/20.354 = 0.0 \leq 0.15 \therefore \phi$

$\phi_{a}/\Phi_{a} + \phi_{bx}/\Phi_{bx} + \phi_{by}/\Phi_{by} = 0.0/20.354 + 8.555/26.4 + 0.423/26.4 = 0.34 \leq 1$ OK 66% under
Checking design member 41

Members: 41
Group: Custom1
Section: RT1.5 x 1.5 x 0.064

Load Case: wind on front

**FY** = 40.0 ksi

On gross area:
\[ F_t = 0.6 \times F_Y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area:
\[ F_t = 0.5 \times F_U = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_v = 0.4 \times F_Y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ \frac{Kl}{r} = \max \left( K_x \frac{l}{r_x}, K_y \frac{l}{r_y} \right) = \max(1.0 \times 4.0/0.586, 1.0 \times 4.0/0.586) = 6.826 \]

Design Member 41, wind on front, Major Bending

Tensile Bending Stress:
\[ f_b \leq F_b, \ 11.331 \leq 26.4 \text{ OK 57\% under } \]

Compressive Bending Stress:
\[ f_b \leq F_b, \ 11.331 \leq 26.4 \text{ OK 57\% under } \]

Design Member 41, wind on front, Major Shear

\[ f_v \leq F_v, \ 4.428 \leq 16.0 \text{ OK 72\% under } \]

Design Member 41, wind on front, Minor Shear

\[ f_v \leq F_v, \ 0.635 \leq 16.0 \text{ OK 96\% under } \]

Design Member 41, wind on front, Tension

On gross area:
\[ f_t \leq F_t, \ 0.023 \leq 24.0 \text{ OK 100\% under } \]

On net area:
\[ f_t \leq F_t, \ 0.023 \leq 44.0 \text{ OK 100\% under } \]

Design Member 41, wind on front, Compression

\[ f_a \leq F_a, \ 0.0 \leq 23.658 \text{ OK 100\% under } \]

Design Member 41, wind on front, Bending + Tension

\[ \frac{f_v}{F_a} \times \frac{F_x}{F_y} + f_t/F_Y = 0.023/24.0 + 11.331/26.4 + 2.429/26.4 = 0.522 \leq 1 \text{ OK 48\% under } \]

Design Member 41, wind on front, Bending + Compression

\[ f_a/F_a = 0.0/23.658 = 0.0 \leq 0.15 : \phi_0 \]

\[ \phi_0 = \frac{0.0/23.658 + 11.331/26.4 + 2.429/26.4 = 0.521 \leq 1 \text{ OK 48\% under } }{0.0/23.658 + 11.331/26.4 + 2.429/26.4 = 0.521 \leq 1 \text{ OK 48\% under } } \]

Load Case: climber

**FY** = 40.0 ksi

On gross area:
\[ F_Y = 0.6 \times F_Y = 0.6 \times 40.0 = 24.0 \text{ ksi} \]

On net area:
\[ F_Y = 0.5 \times F_U = 0.5 \times 88.0 = 44.0 \text{ ksi} \]

\[ F_Y = 0.4 \times F_Y = 0.4 \times 40.0 = 16.0 \text{ ksi} \]

\[ \frac{Kl}{r} = \max \left( K_x \frac{l}{r_x}, K_y \frac{l}{r_y} \right) = \max(1.0 \times 4.0/0.586, 1.0 \times 4.0/0.586) = 6.826 \]
Calc by: FJC
AquaClimb
11/24/2009

Checked by: Gary K. Munkel & Associates – Structural Engineers
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\[
F_a = (1 - (KL/r)^2/(2+Cc^2)) \cdot F_y / FS = (1 - 6.826^2/(2+119.63^2)) \cdot 40.0 / 1.688 = 23.658 \text{ ksi}
\]

**Major Axis:**
\[
F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**
\[
F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi}
\]

**Design Member 41, climber, Major Bending**

Tensile Bending Stress:
\[
f_b \leq F_b, \ 3.486 \leq 26.4 \text{ OK 87\% under}
\]

Compressive Bending Stress:
\[
f_b \leq F_b, \ 3.486 \leq 26.4 \text{ OK 87\% under}
\]

**Design Member 41, climber, Major Shear**

\[
f_s \leq F_s, \ 1.352 \leq 16.0 \text{ OK 92\% under}
\]

**Design Member 41, climber, Minor Bending**

Tensile Bending Stress:
\[
f_b \leq F_b, \ 0.977 \leq 26.4 \text{ OK 96\% under}
\]

Compressive Bending Stress:
\[
f_b \leq F_b, \ 0.977 \leq 26.4 \text{ OK 96\% under}
\]

**Design Member 41, climber, Minor Shear**

\[
f_s \leq F_s, \ 0.258 \leq 16.0 \text{ OK 98\% under}
\]

**Design Member 41, climber, Tension**

On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100\% under} \)

On net area \( f_t \leq F_t, \ 0.0 \leq 44.0 \text{ OK 100\% under} \)

**Design Member 41, climber, Compression**

\[
f_a \leq F_a / F_t = 0.009 \leq 23.658 \text{ OK 100\% under}
\]

**Design Member 41, climber, Bending + Tension**

\[
f_t / F_t + f_b / F_b + f_y / F_y = 0.0 / 44.0 + 3.486 / 26.4 + 0.977 / 26.4 \leq 1 \text{ OK 83\% under}
\]

\[
f_t / F_t + f_b / F_b + f_y / F_y = 0.009 / 23.658 + 3.486 / 26.4 + 0.977 / 26.4 \leq 1 \text{ OK 83\% under}
\]

**Load Case: wind on back**

\[
F_y = 40.0 \text{ ksi}
\]

On gross area \( \frac{F_t}{F_t} = 0.6 \cdot F_y = 0.6 \cdot 40.0 = 24.0 \text{ ksi} \)

On net area \( \frac{F_t}{F_t} = 0.5 \cdot F_u = 0.5 \cdot 88.0 = 44.0 \text{ ksi} \)

\[
KL/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 4.0 / 0.586, 1.0 \cdot 4.0 / 0.586) = 6.826
\]

\[
F_a = (1 - (KL/r)^2/(2+Cc^2)) \cdot F_y / FS = (1 - 6.826^2/(2+119.63^2)) \cdot 40.0 / 1.688 = 23.658 \text{ ksi}
\]

**Major Axis:**
\[
F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi}
\]

**Minor Axis:**
\[
F_b = 0.66 \cdot F_y = 0.66 \cdot 40.0 = 26.4 \text{ ksi}
\]

**Design Member 41, wind on back, Major Bending**

Tensile Bending Stress:
\[
f_b \leq F_b, \ 11.331 \leq 26.4 \text{ OK 57\% under}
\]

Compressive Bending Stress:
\[
f_b \leq F_b, \ 11.331 \leq 26.4 \text{ OK 57\% under}
\]

**Design Member 41, wind on back, Major Shear**

\[
f_s \leq F_s, \ 4.428 \leq 16.0 \text{ OK 72\% under}
\]

**Design Member 41, wind on back, Minor Bending**

Tensile Bending Stress:
\[
f_b \leq F_b, \ 2.429 \leq 26.4 \text{ OK 91\% under}
\]

Compressive Bending Stress:
\[
f_b \leq F_b, \ 2.429 \leq 26.4 \text{ OK 91\% under}
\]

**Design Member 41, wind on back, Minor Shear**

\[
f_s \leq F_s, \ 0.635 \leq 16.0 \text{ OK 96\% under}
\]

**Design Member 41, wind on back, Tension**

On gross area \( f_t \leq F_t, \ 0.0 \leq 24.0 \text{ OK 100\% under} \)
On net area $f_t \leq F_t$, 0.0 $\leq$ 44.0 OK 100% under

**Design Member 41, wind on back, Compression**

$f_a \leq F_a$, 0.023 $\leq$ 23.658 OK 100% under

**Design Member 41, wind on back, Bending + Tension**

$f_a/F_a+f_{bx}/F_{bx}+f_{by}/F_{by}=0.0/44.0+11.331/26.4+2.429/26.4=0.521 \leq 1$ OK 48% under

**Design Member 41, wind on back, Bending + Compression**

$f_a/F_a=0.023/23.658=0.001 \leq 0.15 \therefore \psi_0$

$\phi_a/\Phi_a+\phi_{b\xi}/\Phi_{b\xi}+\phi_{b\zeta}/\Phi_{b\zeta}=0.023/23.658+11.331/26.4+2.429/26.4=0.522 \leq 1$ OK 48% under
## REACTIONS AT ANCHORS

### Joint #

<table>
<thead>
<tr>
<th>Joint</th>
<th>Wind on Back</th>
<th>Climber</th>
<th>Wind on Front</th>
</tr>
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<tbody>
<tr>
<td>27</td>
<td>-46.49</td>
<td>1.814</td>
<td>46.49</td>
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<tr>
<td>28</td>
<td>46.49</td>
<td>1.814</td>
<td>-46.49</td>
</tr>
<tr>
<td>29</td>
<td>-8.714</td>
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</tr>
<tr>
<td>30</td>
<td>8.714</td>
<td>3.457</td>
<td>8.714</td>
</tr>
<tr>
<td>Total</td>
<td>(Global) Rx=0.000</td>
<td>Ry=250.000</td>
<td>Rz=0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**USE 5/8” diameter A304 stainless steel threaded rod & HILTI HDI drop in anchor**

**In 4000 psi concrete T allow = 2,630 lbs & V allow=4,510 lbs** by inspection OK

**Note:** Others to check material in which anchors are embedded for capacity to support anchor forces.